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BRIEFING



Evaluation and Recommendations for Improvement of the Department of Defense Small Business Innovation Research (SBIR) Program

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Prepared for the Office of the Secretary of Defense

Approved for public release; distribution unlimited



NATIONAL DEFENSE RESEARCH INSTITUTE

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PREFACE

In fiscal year 2004, the Director of the Department of Defense Small Business Technology and Industrial Base Office (SBTIBO) requested that the RAND National Defense Research Institute, a division of the RAND Corporation, examine the Department of Defense's (DoD's) Small Business Innovation Research (SBIR) program. The purpose of the research project was to provide DoD with insights into the current status of its SBIR program in terms of the department's transformational technology priorities, innovation, and the small business defense industrial base. Following that initial assessment, the project's objective became the recommendation of policy options for making the DoD SBIR program more responsive to the needs of the department. This documented briefing provides both a record of the research that was conducted in the second half of 2004 and the recommendations that resulted from it.

This documented briefing should be of interest to government managers responsible for administering and using the SBIR program. In addition, the small business community should find this briefing relevant in its efforts to contract and partner with the federal government. Finally, and perhaps most importantly, we expect that those in the executive and legislative branches of government who are responsible for developing policy around the relationship between the small business community and the federal government will find the research and recommendations of this briefing to be of interest.

This research was sponsored by SBTIBO and conducted within the Acquisition and Technology Policy Center of the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Department of the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community.

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SUMMARY

This project comprised four parts. First, the study team gained a broad understanding of the SBIR program. Next, the team evaluated the DoD SBIR program's success in terms of the current set of goals for the program as measured by the department's current set of SBIR metrics, as well as by additional RAND-developed metrics. Since the DoD SBIR program's goals reflect little of DoD's broader national security mission, the third part of the study developed a set of DoD-specific goals for its SBIR program that better reflect the national security mission of the department. This task also entailed suggesting a number of additional SBIR metrics to assess progress against the proposed goals. The study concludes with a number of policy options, which, if implemented, could make the DoD SBIR program more responsive to the department's broader defense mission.

THE DOD SBIR PROGRAM HISTORY AND STRUCTURE

The Small Business Innovation Development (SBID) Act of 1982 (Public Law 97-219) created the Small Business Innovation Research (SBIR) program by mandating that all federal research, development, test, and evaluation (RDT&E) agencies that award more than \$100 million in research and development (R&D) contracts annually create a SBIR program and set aside 1.25 percent of that extramural R&D budget for funding small business research awards. That set-aside percentage has grown over two legislative reauthorizations of the program (Public Laws 102-564 and 106-554); it is currently set at 2.5 percent of DoD's extramural R&D budget. The SBID Act outlined four broad congressional goals:

- Stimulate technological innovation.
- Use small businesses to meet federal R&D needs.
- Foster and encourage participation by minority and disadvantaged persons in technological innovation.
- Increase the private-sector commercialization of innovations derived from federal R&D.

Over the years, Congress has emphasized the commercialization aspects of the SBIR program. This emphasis has resulted in efforts to both better measure commercialization and include it as a selection criterion when making SBIR awards.

Congressional testimony prior to the reauthorizations, interim General Accounting Office (GAO)¹ reports, and the actual reauthorization texts strongly suggest that Congress believes the SBIR program to be effective in meeting its broader goals and will most likely continue to support the program.

In 2003, the DoD SBIR program was about \$900 million and represented about 63 percent of the total federal SBIR budget, making it the largest of the ten federal SBIR programs. The department's 2004 and 2005 SBIR budgets exceed \$1 billion.

DoD has decentralized administration of almost all aspects of its SBIR program. This means that topic generation, budgeting, and research emphasis are managed by the department's military services and defense agencies. At the Office of the Secretary of Defense (OSD) level, the Office of Small and Disadvantaged Business Utilization (SADBU)² manages SBIR policy and the centralized solicitations for DoD's entire SBIR program. The Office of the Director of Defense Research and Engineering within the Office of the Secretary of Defense for Acquisition, Technology and Logistics (OSD AT&L) also has a role in the SBIR program; it reviews (technically and administratively) research topics suggested by the various military departments and agencies for redundancy, clarity, and alignment.

The DoD SBIR program is structured into three phases: feasibility, principal R&D, and commercialization. Small businesses initially compete to win Phase I (feasibility) awards. The purpose of Phase I is to determine the scientific and technical merit of the proposed effort. Phase I contracts typically last up to six months and are normally funded at \$70,000 to \$100,000. The SBIR Phase I awardees with the most promising projects and results are invited to submit proposals for a

¹ Now the Government Accountability Office.

² Now the Office of Small Business Programs.

Phase II contract. Phase II is intended as the primary R&D phase. Up to two years and \$750,000 may be allocated for Phase II performance. Phase III is essentially any additional work that follows from Phase II, although no SBIR funds are dedicated to Phase III. Instead, SBIR Phase II finishers are expected to obtain private funding or other non-SBIR federal funding to develop their research results for military or commercial markets.

DOD SBIR PROGRAM GOALS AND METRICS

DoD's broad goal for its SBIR program is "to harness the innovative talents of our nation's small technology companies for U.S. military and economic strength." Beyond this broad statement, however, DoD merely restates the goals of the SBID Act:

- Stimulate technological innovation.
- Increase private-sector commercialization of federal R&D.
- Increase small business participation in federally funded R&D.
- Foster participation by minority and disadvantaged firms in technological innovation.

As a result, evaluation of the DoD SBIR program focuses on these four goals. Although the DoD SBIR program is aimed at defense-related R&D through the topic selection process, there is currently no systemic assessment of the extent to which the outcomes of the thousands of DoD SBIR contracts completed to date have contributed to the department's primary national security mission.

The DoD SBIR program's first goal--to stimulate innovation--has two components. The first is the input side, "Stimulation." This is measured simply by counting the number of topics included in each solicitation, the number of proposals received, the number of SBIR contracts awarded, and ultimately how much money DoD spends on the program. The output side, "Innovation," is more difficult to measure, and there is, in fact, little attempt to do so within DoD.

As a result, RAND's evaluation of this goal focused on innovation. The RAND study team noted that companies the Office of the Deputy Under Secretary of Defense (Industrial Policy) identifies as

"transformational" make heavy use of the DoD SBIR program.³ Additionally, in a survey of companies that entered the DoD market through the SBIR program, the study found that half the companies were start-ups and that a significant number of patents were associated with the start-ups. From this, the study team inferred that the SBIR program was stimulating innovative activity. It was not clear, however, whether this innovative activity was greater or less than a similar amount of funding some other R&D program would generate.

The second goal—commercialization of federal R&D—is measured in two ways: through "success stories" and the Commercialization Achievement Index (CAI). "Success stories" are anecdotes of DoD SBIR commercialization. While interesting, they provide little value in determining overall commercialization success. More importantly, DoD has developed the CAI, which measures the commercialization success of previous SBIR Phase II award winners when they compete for new Phase I awards. The introduction of the CAI is a positive development. It provides a quantitative measure of commercialization success that assists in evaluating both the individual small businesses and the overall DoD SBIR program. That said, the CAI can be improved. Currently, all information that is included in the CAI is self-reported by the small businesses with their Phase I proposals, and no auditing is done to validate the figures. Additionally, the CAI is not applied to as many companies as it could be, nor does it seem to act as a strong discriminator when selecting Phase I awardees.

The RAND study team looked for additional indicators of commercialization activity. The team noted, for example, that in a sample of 40 SBIR companies, commercial success in two cases could be linked to the SBIR program. An examination of non-SBIR DoD contracting also found that in a sample of almost 500 DoD SBIR award winners entering the DoD market through the SBIR program, the cumulative value of the non-SBIR contracts these companies were awarded by DoD exceeded the cumulative value of their DoD SBIR contracts. This finding is

³ The report that identified companies as transformational (DoD, 2003b) did not define "transformational." We made the assumption that some level of innovation was implied in the term.

mitigated, however, by the fact that 95 percent of the non-SBIR contracting was concentrated in just 1 percent of the sample.

The DoD SBIR program goal of increasing small business participation in federally funded R&D is measured by the dollars spent on the program. The current size of the DoD SBIR program, about \$1 billion per year, has been achieved through an average annual growth rate of about \$43 million per year over the past 20 years, ensuring that small business participation in the program has increased. Additionally, the program introduces small businesses to the DoD market. DoD claims that a third of the companies awarded Phase I contracts are new to the DoD market.

RAND's evaluation of the goal to increase small business participation in federal R&D found that over the past decade, 20 to 25 percent of the companies winning DoD SBIR awards, 375 in 2003 alone, were new to the DoD market. However, the RAND study team also found that the SBIR program represents a relatively small part (less than 25 percent) of DoD's R&D contracting with small businesses.

DoD measures the goal of fostering participation by minority and disadvantaged firms in technological innovation by counting the number of firms claiming women- and minority-owned status. According to DoD, the percentage of these kinds of firms in its SBIR program has grown over time and now represents approximately 20 percent of participating small businesses.

Rather than looking at the number of women- and minority-owned firms participating the SBIR program, RAND examined the value of the DoD SBIR contracts going to these firms and compared this to the value of all DoD R&D contracts going to small, minority-, or women-owned businesses. The findings indicate that, while the SBIR program has succeeded in contracting with women- and minority-owned firms, the percentage of SBIR dollars going to these firms is smaller than the percentage of dollars going to similar firms across all DoD R&D contracts with small, minority-, or women-owned businesses. This is most likely due to the fact that there are other programs aimed specifically at increasing the rate at which disadvantaged small businesses participate in federal contracting. These programs give economically or socially disadvantaged firms advantages in competition for federal

contracts. The DoD SBIR program does not provide these advantages to disadvantaged small businesses, and therefore these companies will naturally tend to migrate to the programs that do.

Based on both DoD's own measures and this study's examination of the available data, it appears that the DoD SBIR program generally accomplishes the goals set out in the program's enabling legislation. That is, the legislated amount of money is spent on R&D contracts with small businesses, hence "stimulating" innovation. On the output side of the R&D process, companies identified as "transformational" take greater advantage of the SBIR program, and there is some level of patenting activity, directly and indirectly, associated with the program. Some commercialization of federal R&D also appears to occur as a result of the SBIR program, although how effective the SBIR program is in this area is unclear. The DoD SBIR program clearly attracts a large number of small businesses to the DoD R&D market, and, on average, roughly 250 per year are new to that market. Finally, the SBIR program provides opportunities for minority- and women-owned small businesses to win R&D contracts with DoD, although there seem to be other, more effective programs in DoD for this purpose.

OTHER RAND FINDINGS

During the examination of the SBIR program, the study team found additional information that did not relate directly to the current goals of the DoD SBIR program. These provide additional insights.

In general, DoD's SBIR topic allocation aligns well with the department's R&D priorities while remaining flexible enough to focus topics in areas that are more appropriate for small businesses. That said, the team found that the bulk of the SBIR contracts are focused on basic and applied research rather than later-stage development.

DoD SBIR topics are added at the rate of about one topic for every \$2 million of additional budget. This marks a departure from the first decade of the program, when more than three topics were added for every \$1 million of budget. This change means that more dollars are now available to address each topic, resulting in more Phase I and II contracts awarded per topic.

One issue that is generally included in any discussion of the SBIR program is the perception that there are companies that are frequent award winners. The study team found that frequent award winners do win a large percentage of the total SBIR contracts: 29 percent of all DoD SBIR Phase I contracts in the 1993–2002 period went to companies that won 20 or more SBIR Phase I contracts in that timeframe. More interestingly, this phenomenon is increasing. In 1994, 12 percent of all DoD SBIR Phase I contracts were with companies that had more than five SBIR contract actions in that year alone. By 2003 that percentage had doubled to 25 percent. In addition, the contracting data indicate that the ratio of DoD non-SBIR contract dollars to DoD SBIR contract dollars won by a company generally decreases as the number of SBIR contracts won increases. In other words, frequent SBIR award winners rely more, as a percentage of revenue from DoD, on the SBIR program than occasional SBIR winners do. This pattern may be on the decline, however. In the ten-year period from 1994 to 2003, the ratio of DoD non-SBIR contract dollars to DoD SBIR contract dollars significantly increased for frequent DoD SBIR winners. That trend should continue if the CAI is rigorously used as part of the selection criteria for SBIR awards.

More troubling was a finding that the DoD SBIR program is managed in a manner that may be too lean. While the study team expected the SBIR program to require greater-than-average management attention, the opposite seems to be the case. Resources to manage DoD contracts are generally about 2.7 percent of total contract value. The SBIR program, with the Department of the Navy as the exception, invests just 2 percent of the contract value to SBIR program management. In contrast, venture capital companies, perhaps the best commercial analogy to the DoD SBIR program, earn management fees that range from 2.5 to 5 percent of the fund size and also earn a significant percentage (usually around 20 percent) of return on investment.

This finding reinforces the study team's perception that the primary purpose of participation in the SBIR program, from DoD's perspective, is statutory compliance with the SBID Act. In other words, within DoD the SBIR program is managed more as a tax and burden to be borne than as an R&D resource to be leveraged. The study team initially got this impression during interviews with SBIR managers at the

component and agency levels. It was reinforced as the study team took advantage of a number of opportunities to talk to personnel in DoD labs and program offices about the SBIR program. While these discussions cannot be described as anything more than anecdotal, they nonetheless reinforced the impression that the R&D and acquisition leadership within DoD has been generally unenthusiastic about the SBIR program. Reactions about the SBIR program from small businesses were much more mixed. We found examples of small businesses using the SBIR program in a number of ways: as capital to help new businesses get established, as an entrée into the DoD market, as low-risk capital to conduct high-risk R&D, and as a revenue source for R&D service companies.

RECOMMENDATIONS FOR IMPROVING THE DOD SBIR PROGRAM

The findings of the study team, along with the very substantial size of the DoD SBIR program, naturally lead to the question of how the program could be improved so that DoD can leverage its resources for the department's national security mission while continuing to meet the statutory goals Congress established for the program.

There are three fundamental steps for improving the program. These three steps are all aimed at maximizing the value of the program to DoD rather than merely minimizing its budgetary impact. First, there needs to be continued emphasis within the defense R&D and acquisition communities, particularly at the leadership level, that the SBIR program is an investment that can generate a significant return. At \$1 billion per year, the DoD SBIR program is large enough to warrant substantial leadership attention. Importantly, these funds are very flexible and can be applied to specific problems and priorities without negotiating through the standard R&D programming and budgeting processes. Second, DoD-specific SBIR goals and metrics must be established. Finally, resources must be made available to manage the R&D outcomes from the SBIR program, not just the funding and contracting processes.

The SBIR program can be a part of the Acting Under Secretary of Defense's (Acquisition, Technology and Logistics) seven goals targeted at driving performance outcomes.⁴ Two of these, technology dominance and

⁴ The acting Under Secretary of Defense for Acquisition, Technology and Logistics at the time of this study, and the source of the seven

strengthening the industrial base, are particularly applicable to the SBIR program. Six SBIR-specific goals that address these broader aims are:

Technology dominance

1. Improve invention-to-use time for military technologies.
2. Provide technology intelligence about what development exists or is planned in the United States.
3. Generate innovative solutions to DoD requirements.

Improving the industrial base

4. Broaden DoD's technological base and increase competition by building and strengthening innovative companies willing to do defense work.
5. Improve ties between prime contractors and the small, technology-oriented business community.
6. Expand intellectual capital in the United States.

POLICY OPTIONS FOR THE DOD SBIR PROGRAM

The study team identified a number of policy options for using the DoD SBIR program in ways that can help achieve these goals. In most cases, these options will require that the department invest additional resources into the SBIR program, but such investment holds the promise of extracting much greater value in terms of R&D outcomes from the SBIR program.

1. Emphasize later-stage R&D (6.3, 6.4, and 6.7 stages) rather than basic and applied research in topic selection.
2. Establish a quick-reaction SBIR program that utilizes SBIR resources to address the immediate operational requirements of DoD.
3. Use the SBIR program to understand developments in the commercial technology sector that are not being addressed in other defense-related R&D.

goals, was Michael Wynne. Since this study was completed, Kenneth Krieg has been nominated and confirmed to the position, replacing Mr. Wynne.

4. Write some DoD SBIR topics to address operational, rather than technical, needs in order to explore innovative approaches to solving operational problems.
5. Use the DoD SBIR program as a tool to recruit small businesses that are successful in other federal markets into the DoD market.
6. Combine and integrate the resources of the DoD SBIR program with other DoD R&D funding programs, such as venture capital initiatives and the Manufacturing Technology Program, to provide a stream of funding at all stages of the product development cycle.
7. Look for greater opportunities to involve the defense prime contractors in the DoD SBIR program through mentoring and partnership arrangements with small businesses, such as by linking the SBIR program with the DoD Mentor-Protégé program or by facilitating consultation between DoD and the larger system contractors to identify potential SBIR projects and small businesses of most interest to those contractors managing larger system development.
8. Use the SBIR program to resource a more complex, larger product development effort, such as a small system acquisition program or advanced technology demonstrator, by combining a number of SBIR contracts over a period of time.

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Finally, we thank Nancy Moore of RAND and Dennis Smallwood, a former RAND colleague and former professor of economics at the University of California, who provided comprehensive reviews of the later drafts of this briefing. Their thoughtful comments and helpful suggestions greatly improved the final version.

ABBREVIATIONS

ANC	Alaska Native Corporation
CAGE	Commercial and Government Entity
CAI	Commercialization Achievement Index
CCR	Central Contract Registry
DARPA	Defense Advanced Research Projects Agency
DDR&E	Director of Defense Research and Engineering
DoD	Department of Defense
DTAP	Defense Technology Area Plan
FAW	frequent SBIR award winner
FY	fiscal year
GAO	General Accounting Office (now the Government Accountability Office)
IED	improvised explosive device
IRAD	independent research and development
ManTech	DoD Manufacturing Technology Program
MDA	Missile Defense Agency
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health
OSD	Office of the Secretary of Defense
OT	other transaction
R&D	research and development
RDT&E	research, development, testing, and evaluation
SADBU	Office of Small and Disadvantaged Business Utilization
SBA	Small Business Administration
SBC	small business company
SBID	Small Business Innovation Development
SBIR	Small Business Innovation Research
SBTIBODoD	Small Business Technology and Industrial Base Office
SOCOM	Special Operations Command
STTR	Small Business Technology Transfer
UARC	university-affiliated research center
USPTO	U.S. Patent and Trademark Office

INTRODUCTION AND METHODOLOGY



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***Evaluation and Recommendations for
Improvement of the Department of
Defense Small Business Innovation
Research (SBIR) Program***

DoD SBIR Research Project Objective

To provide insights into the current status of and improvement options for the Department of Defense's (DoD's) Small Business Innovation Research (SBIR) program in terms of transformational technology focus, innovation, and the small business defense industrial base

RAND

Despite being more than two decades old, there has been surprisingly little research conducted to determine the effectiveness of the Small Business Innovation Research (SBIR) program in addressing the research requirements of the various federal agencies and departments involved. The purpose of this research project is to provide the Department of Defense (DoD) with insights into the current status of its SBIR program in terms of the department's transformational technology priorities, innovation, and the small business defense industrial base. Following that initial assessment, the research project's objective became the recommendation of policy options for making the DoD SBIR program more responsive to the needs of the department.

DoD SBIR Research Project Methodology

- **Understand the DoD SBIR program history, objectives, and structure**
 - Literature review
 - Interviews with DoD-level and service/agency SBIR managers
- **Evaluate DoD SBIR program success in meeting the program objectives**
 - Identify and evaluate DoD's SBIR metrics
 - Develop additional metrics from available data
 - Evaluate DoD SBIR program goals and recommend additional goals and metrics
- **Develop policy options to improve DoD program outcomes**

RAND

The RAND Corporation's DoD SBIR research project comprised four parts. First, the study team gained a strong understanding of the SBIR program. This was accomplished through a literature review that relied on previous studies of the SBIR program, published information such as fact sheets and solicitations, and the legal documents (statutes, regulations, directives) associated with the program. Interviews with DoD-level and service and agency SBIR managers were also conducted early in the study to gain an understanding of how the SBIR program is managed across DoD.⁵

Next, the study team evaluated the DoD SBIR program's success as measured by the department's current set of SBIR metrics. The team also developed additional metrics to better evaluate the SBIR program in terms of the current set of goals for the program. Due to time and other resource limitations, the additional metrics were, in general, developed

⁵ A list of interview questions is found at Appendix D.

only from information already available or provided to us by our sponsor.⁶

We learned early in our research that the DoD SBIR program goals reflected little of DoD's broader national security mission. As a result, we took it as part of the research project to reevaluate DoD's goals for its SBIR program to better reflect the national security mission of the department. As part of this reevaluation, the study team suggested a number of additional SBIR metrics to assess progress against the proposed DoD SBIR program goals.

Finally, we brainstormed and came up with a number of policy options with the intention of making the DoD SBIR program more responsive to the department's broader defense mission. The options that are presented later in this briefing are not dealt with in any detail as yet. Instead, they are intended as starting points for developing a SBIR program that addresses the legislative intent behind the creation of the federal SBIR program, while simultaneously delivering value to DoD.

⁶ Other than a number of very limited case studies, no attempt was made to develop additional data sources, such as through the use of survey instruments.

DOD SBIR PROGRAM AND HISTORY***Outline***

- **DoD SBIR program and history**
- **DoD SBIR goals and metrics**
 - DoD's evaluation of current goals
 - RAND's evaluation of current goals
- **Other RAND findings**
- **Improving the DoD SBIR program**
- **Conclusions**

RAND

We begin with a discussion of the SBIR program and its history. Next we address DoD's goals for its SBIR program and examine how those goals are currently evaluated. With that as background, the discussion will turn to RAND's assessment of how well DoD is meeting its SBIR goals, including additional findings that we discovered along the way. Finally, the discussion of the current status of the SBIR program leads to the policy question of how to improve the DoD SBIR program.

Legislative History

- **Initiating legislation: Small Business Innovation Development Act of 1982 – Set aside 1.25% of extramural research and development (R&D) funding for contracts with small business**
 - To stimulate technological innovation
 - To use small business to meet federal research and development needs
 - To foster and encourage participation by minority and disadvantaged persons in technological innovation
 - To increase private-sector commercialization of innovations derived from federal research and development
- **Reauthorized in 1992**
 - Emphasis placed on commercial success as a selection criteria
 - Set-aside increased to 1.5%
- **Reauthorized again 2000**
 - Emphasis on gathering data and analyzing SBIR outcomes
 - Set-aside increased to 2.5%

RAND

The Small Business Innovation Development (SBID) Act of 1982 created the SBIR program by mandating that each federal research, development, test, and evaluation (RDT&E) agency with an extramural research and development (R&D) budget⁷ more than \$100 million create a SBIR program and set aside 1.25 percent of its extramural budget for funding small business research awards.⁸ The SBID Act outlined four broad congressional goals:

- To stimulate technological innovation
- To use small business to meet federal R&D needs
- To foster and encourage participation by minority and disadvantaged persons in technological innovation

⁷ With some exceptions, extramural budgets are defined as “[t]he sum of the total obligations for R/R&D [research/research and development] minus amounts obligated for R/R&D activities by employees of a Federal agency in or through Government-owned, Government-operated facilities” (U.S. Small Business Administration, 2002).

⁸ Public Law 97-219.

- To increase the private sector commercialization of innovations derived from federal R&D.⁹

In 1992, Congress found that the SBID Act was effective in meeting the above goals, reauthorized it for eight more years, expanded the set-aside amount to 1.5 percent, and emphasized commercial success as an important selection criterion.¹⁰

The 2000 reauthorization further increased the set-aside amount to 2.5 percent and mandated that data be collected to monitor commercial success.¹¹ The Small Business Administration (SBA) established the TECH-Net database for that purpose. This database includes information about the firms that won SBIR contracts and provides research abstracts for the projects. There is also a commercialization section, although access to that section is limited.

Congressional testimony prior to the reauthorizations, interim General Accounting Office (GAO)¹² reports, and the actual reauthorization texts strongly suggest that Congress believes the SBIR program to be effective in meeting its broader goals;¹³ thus, Congress will most likely continue to support the program.¹⁴

⁹ Public Law 97-219, Section 2(b).

¹⁰ Public Law 102-564.

¹¹ Public Law 106-554.

¹² Now the Government Accountability Office.

¹³ See the bibliography for a list of the testimony, GAO reports, and reauthorization texts.

¹⁴ For example, a 1998 Senate report states of the GAO's finding that SBIR "is a worthwhile program that is running very well." (U.S. Senate, 1998).

SBIR Program Structure

- **Most federal agencies with extramural R&D budgets more than \$100 million are required to spend 2.5% of that funding on the SBIR program**
- **DoD is the largest SBIR participant in the federal government (63% of the total program in 2003)**
- **DoD currently invests about \$1 billion per year in SBIR contracts**
- **DoD SBIR program execution is decentralized and generally managed by the military services and various defense agencies with three exceptions:**
 1. **The Office of the Director of Defense Research and Engineering (DDRE) evaluates and coordinates all DoD SBIR topics**
 2. **The Small and Disadvantaged Business Utilization Office (SADBU) manages DoD-wide SBIR solicitations**
 3. **SADBU prepares and coordinates DoD SBIR policy**

RAND

The SBID Act of 1982 requires that each federal agency¹⁵ with an extramural R&D budget of \$100 million per year or more participate in the SBIR program¹⁶ and administer the program unilaterally.¹⁷ Currently, there are ten major federal agencies participating in the SBIR program.¹⁸ The total federal SBIR budget for 2004 was \$1.6 billion, 63 percent (approximately \$1 billion) of which was funded by DoD.¹⁹

While law requires that the Army, Air Force, and Navy manage their SBIR programs, DoD goes further and has decentralized administration of nearly the entire department's SBIR program. The military departments administer their programs, as do all the various DoD subagencies with large enough R&D budgets to have SBIR programs.

¹⁵ The act defines federal agency as an executive or military department (15 USC 638(e)(2)).

¹⁶ 15 USC 638(f).

¹⁷ 15 USC 638(g).

¹⁸ The Departments of Agriculture, Commerce, Defense, Education, Energy, Transportation, and Health and Human Services; the Environmental Protection Agency; the National Aeronautics and Space Administration (NASA); and the National Science Foundation (NSF) (U.S. Small Business Administration, 2001).

¹⁹ U.S. Department of Defense (2004c).

Each defense service or subagency structures and operates its SBIR program to meet its assigned research mission. Our interviews of military service and defense agency SBIR directors found that each had stand-alone topic generation and review processes, unique budget and overhead allocation philosophies, and different research emphases.

The three major exceptions to decentralized DoD SBIR program execution are topic review, solicitations, and policy development. The Director of Defense Research and Engineering (DDR&E) collects and reviews (technically and administratively) research topics suggested by the various military departments and agencies for redundancy, clarity, and alignment with DoD's science and technology objectives.²⁰ Once approved, topics are included in broad solicitations managed by the Office of Small and Disadvantaged Business Utilization (SADBU).²¹ This is done to help standardize the solicitation and proposal response process, making it easier for interested small businesses to participate in the program. In 2004, DoD issued four broad solicitations, although there had been only two solicitations per year from 1992 to 2003—except in 1995, when there were three.²² SADBU also prepares and coordinates the overall SBIR policy for DoD.

²⁰ During interviews, all the service and agency-level SBIR program managers expressed general frustration with the topic review process as currently managed by DDR&E. SBIR topics are initially generated in a bottom-up process. Laboratories, program offices, and R&D centers suggest topics based on their current research agendas, which are linked to the Defense Technology Area Plan (DTAP). Suggested topics move up through various levels of review, although the exact process is service and agency dependent. Eventually, all suggested topics are forwarded to DDR&E for final review. SBIR managers complained that the DDR&E review was time consuming and that reviewers at the DDR&E level often did not have the expertise to effectively conduct the reviews. Although rejected topics may be revised and resubmitted, SBIR program managers felt that there was often too little time to effectively amend rejected topics.

²¹ Now the Office of Small Business Programs.

²² U.S. Department of Defense (2004b).

SBIR Program Structure (cont.)

Three-Phase Program

- **Phase I: Feasibility**
 - Competitive
 - Determine scientific and technical merit
 - Six months
 - Up to \$100,000 (+)
- **Phase II: Principal R&D**
 - Award based on Phase I results and proposal evaluation
 - Two years
 - Up to \$750,000 (+)
- **Phase III: Commercialization**
 - Product development for commercial or military markets
 - No SBIR funds or other dedicated federal monies

RAND

The DoD SBIR program comprises three phases: feasibility, principal R&D, and commercialization. The feasibility phase (Phase I) is the only part of the program in which small businesses directly compete for SBIR funding. The purpose of Phase I is

to determine the scientific and technical merit and feasibility of the proposed effort and the quality of performance of the SBC [Small Business Company] with a relatively small agency investment before consideration of further federal support in Phase II.²³

These contracts typically last up to six months and normally are funded at \$70,000 to \$100,000. DoD evaluates the Phase I results on scientific, technical, and commercial merit. The most promising Phase I companies are invited to submit proposals for a Phase II contract.²⁴

²³ U.S. Small Business Administration (2002).

²⁴ There are no set standards for deciding which Phase I companies are selected for continuation to Phase II. Criteria such as technical

SBIR Phase II contracts are meant to continue the R&D projects initiated in Phase I. It is in Phase II that nearly all the significant R&D occurs. As one would expect, time normally allocated to Phase II contracts and the amount of the Phase II award are significantly more than for Phase I. DoD Phase II contracts normally last up to two years, and the value of the contract can be up to \$750,000. It should be noted that the \$100,000 Phase I and \$750,000 Phase II caps are not absolute. An awarding agency may determine that a particular SBIR award merits greater funding. Such awards require only that, after the fact, a written justification be submitted along with the annual SBIR report to the SBA.²⁵

As noted above, one of the goals of the SBIR program is the commercialization of federally funded R&D. Phase III addresses that goal and includes any additional work that "derives from, extends, or logically concludes effort(s) performed under prior SBIR funding agreements."²⁶ Significantly, no SBIR funds are dedicated to Phase III. Instead, SBIR Phase II finishers are expected to obtain private funding or other non-SBIR federal funding to develop their research results for military or commercial markets.

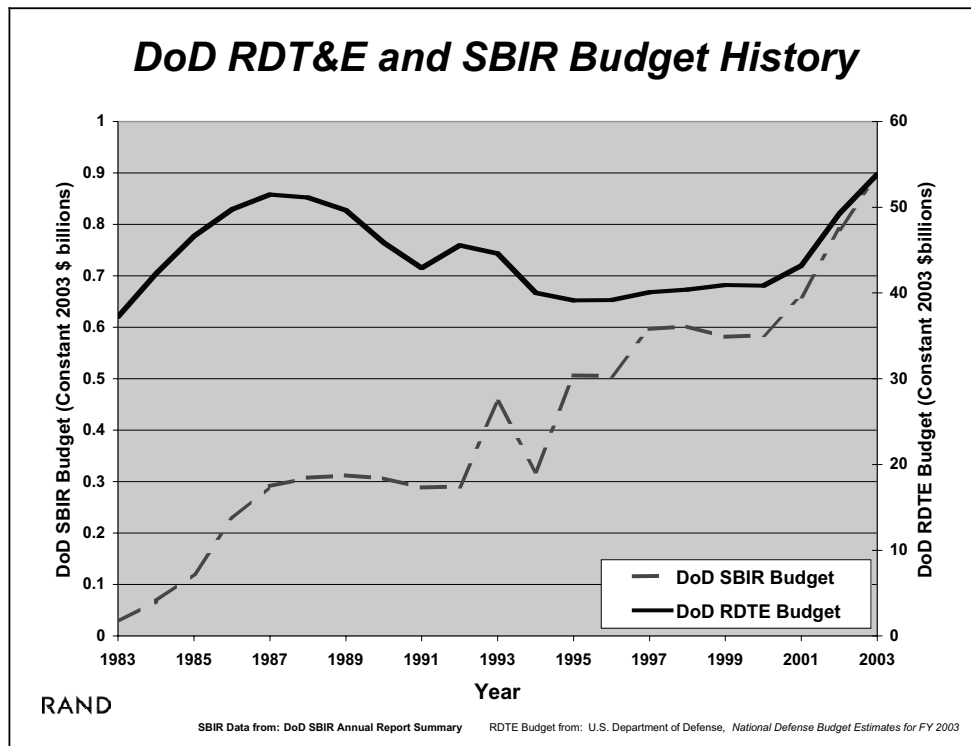
Historically, about 15 percent of SBIR proposals are awarded a Phase I contract, and approximately 40 percent of Phase I projects are subsequently awarded a Phase II contract.²⁷ There are very little data available for understanding how many Phase II winners are successful in eventually commercializing their research. We will discuss commercialization in greater detail in the next two sections of this briefing.

merit, Phase I performance, and continuing need for the research all contribute to the selection decision. In some cases, two or more companies may win a Phase I award in response to a particular topic. In such cases, Phase I may provide a means for further examination of the competing research approaches to the topic. Phase II then represents a down-select of the most promising of these.

²⁵ U.S. Small Business Administration (2002).

²⁶ U.S. Small Business Administration (2002).

²⁷ U.S. Department of Defense (2004c).



Over the past two decades, funding for the DoD SBIR program grew both as a percentage of the department's extramural R&D budget and in absolute terms. As noted earlier, when the program was established in 1984, participating federal agencies were required to set aside 1.25 percent of their extramural R&D funding for the SBIR program. Since then, Congress has doubled the contribution to 2.5 percent of extramural R&D funding and the total RDT&E budget has increased nearly 50 percent in real terms.²⁸ As a result, the DoD SBIR budget grew from just a few million dollars in 1983 to almost a billion dollars in 2003.²⁹

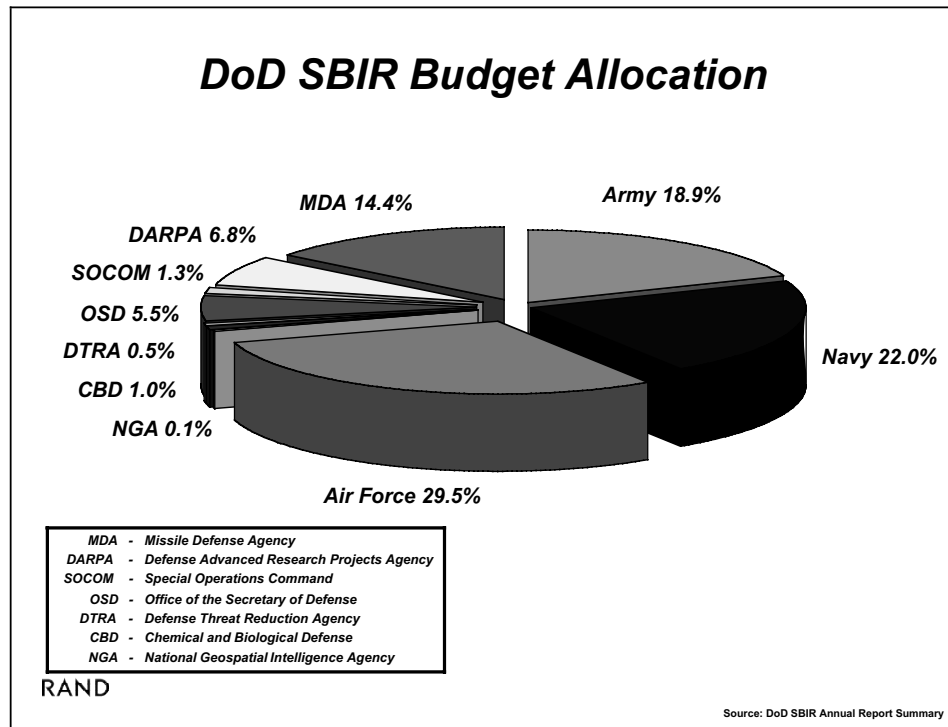
The DoD SBIR program has contracted out very significant amounts of money for some time, but one gets the impression that the billion-dollar "milestone" is significant, at least in a psychological sense. To

²⁸ The RDT&E budget is from U.S. Department of Defense (2002b). The SBIR budget is from U.S. Department of Defense (2005a).

²⁹ The SBIR budget for 2004 was not published at the time of this writing. As a result, the chart displays DoD RDT&E and SBIR budgets through 2003. The RDT&E budget for 2004 was published, however, and is \$60 billion. This level of RDT&E spending should result in a \$1 billion SBIR budget for 2004.

paraphrase a quote usually attributed to the late Senator Everett Dirksen, a billion dollars is "real money."³⁰

³⁰ Senator Dirksen may not have said the famous quote often attributed to him (Dirksen Congressional Center, 2004).



The DoD SBIR budget is allocated among the ten DoD participating services and subagencies. The Air Force, Army, and Navy provide 30, 22, and 19 percent, respectively, of the DoD SBIR budget, or roughly two-thirds of the total. The Missile Defense Agency (MDA), at 14 percent, and the Defense Advanced Research Projects Agency (DARPA), at 7 percent, account for another fifth of the total DoD SBIR budget. Less than 10 percent is split among the remaining agencies (the Office of the Secretary of Defense [OSD], 5.5 percent; Special Operations Command, 1.3 percent; the Joint Program Executive Office for Chemical and Biological Defense, 1 percent; the Defense Threat Reduction Agency and the National Geospatial-Intelligence Agency, each at less than 1 percent).³¹ Note that of the roughly \$0.9 billion DoD SBIR budget in FY 2003, each service's share was at least \$169 million, MDA's SBIR budget was nearly \$130 million, and DARPA's SBIR budget was around \$60 million.

³¹ U.S. Department of Defense (2005a).

SBIR Oversight Process

- **Annual Report to SBA/Congress**
- **Congressional Reauthorization**
- **Congressionally Directed External Reviews**

RAND

Each federal agency that is required to have a SBIR program, including DoD, is required to submit a simple and standardized annual report that meets the SBA's data requirements.³² The SBA, serving as the

³² The SBA requires each agency to report annually: (1) total fiscal year extramural R&D obligations; (2) total fiscal year SBIR program dollars as calculated by applying the statutory per centum; (3) total fiscal year SBIR program obligations; (4) the total topics and subtopics for each solicitation; (5) the number of proposals received for each topic and subtopic; (6) awardee information, including name; address; solicitation topic or subtopic; contract amount; whether the awardee is a women owned, socially disadvantaged, or a Historically Underutilized Business Zone SBC; and any follow-on funding commitments; (7) justification for awards exceeding \$100,000 (Phase I) and \$750,000 (Phase II); (8) how many Phase I awards were processed in greater than six months; (9) federally non-SBIR funded Phase III award information; (10) justification for and awardee information for Phase I awards made when only one proposal was received for a topic; (11) information (including commercialization status) concerning awards made to SBCs that have been awarded more than 15 Phase II awards in the preceding five years; (12) the number and identification of awards related to National Critical Technology topics; (13) information concerning continued agency activity in relation to a SBIR-developed technology when that activity determines it impracticable to enter into a follow-on, non-SBIR funding agreement with the SBIR awardee that developed the technology; (14) a

representative for the executive branch, compiles all agencies reports into one annual federal SBIR report that is submitted to Congress. The SBA also presents a summary of its report to the Senate Small Business Committee and the House Science and Small Business committees.

Legislatively, the SBIR program requires periodic reauthorization, and Congress has used these opportunities to reevaluate the program. This evaluation process involves soliciting testimony from public- and private-sector experts in small business and technology policy, as well as from participating firms and government officials.³³ Additionally, Congress uses these opportunities to direct studies to evaluate the effectiveness of the overall SBIR program.³⁴

comparison of SBIR and non-SBIR awards to other than SBCs (U.S. Small Business Administration, 2002).

³³ For example, when considering the FY 2000 reauthorization of the SBIR program, the Senate Committee on Small Business held one hearing and two roundtable meetings concerning the program (U.S. Senate Report 106-289, 2000).

³⁴ In the 1992 program reauthorization, Congress required the U.S. the General Accounting Office to review the SBIR program to ensure that federal agencies were meeting the statutory requirements for program implementation and to measure the impact the program has had on the agencies and on participating firms (Public Law 102-564). The FY 2000 reauthorization also required an independent assessment of the program, and directed the National Academies of Science through its National Research Council to conduct the study. When completed, this study should be comprehensive, covering matters such as the quality of the research, how well the participating federal agencies are utilizing the results of the research, whether there are continuing relationships between SBIR firms and the federal agencies involved, and, to the extent practicable, the economic impact of the program (Public Law 106-554). At the time of this writing, the National Research Council study was ongoing.

DOD SBIR GOALS AND METRICS**DOD'S EVALUATION OF CURRENT GOALS*****Outline***

- DoD SBIR program and history
- **DoD SBIR goals and metrics**
 - **DoD's evaluation of current goals**
 - RAND's evaluation of current goals
- Other RAND findings
- Improving the DoD SBIR program
- Conclusions

RAND

We next examine how DoD defines its SBIR goals and its own measures of how well it is meeting those goals.

Current Goals of the DoD SBIR Program Reflect the Legislative Intent

Harness the innovative talents of our nation's small technology companies *for U.S. military and economic strength*

- 1. Stimulate technological innovation**
- 2. Increase private-sector commercialization of federal R&D**
- 3. Increase small business participation in federally funded R&D**
- 4. Foster participation by minority and disadvantaged firms in technological innovation**

RAND

Source: OVERVIEW - DoD's SBIR and STTR Programs,
<http://www.acq.osd.mil/sadbu/sbir/overview/index.htm>

DoD publishes its SBIR goals in two parts. First is the broad statement that "[t]he purpose of the DoD's SBIR and STTR [Small Business Technology Transfer] programs is to harness the innovative talents of our nation's small technology companies *for U.S. military and economic strength*."³⁵ Second, because this policy statement is too broad to evaluate the overall effectiveness of the SBIR program, it is restated with the following narrower goals of the federal SBIR program:

- Stimulate technological innovation.
- Increase private-sector commercialization of federal R&D.
- Increase small-business participation in federally funded R&D.
- Foster participation by minority and disadvantaged firms in technological innovation.

Restating the federal SBIR goals as a statement of the DoD SBIR program goals fully aligns the department's program with the legislative

³⁵ U.S. Department of Defense (2004d). Emphasis added.

intent. However, it does not address the national security relevance embedded in the broader goal. Thus, although the DoD SBIR program is aimed at defense-related R&D through the topic selection process, there is currently no systemic assessment of the extent to which the outcomes of the thousands of DoD SBIR contracts completed to date have contributed to the department's primary national security mission. This raises the issue of whether additional DoD SBIR program goals that address the national security mission of the department can be developed and evaluated while maintaining the program's compatibility with Congress's intent.

Defining the DoD SBIR Program Goals

- **The SBA's SBIR Program Policy Directive defines:**

- **Commercialization** - The process of developing *marketable* products or services and producing and delivering products or services for sale (whether by the originating party or by others) to government or commercial markets
- **Innovation** - Something new or improved, having *marketable* potential, including (1) development of new technologies, (2) refinement of existing technologies, or (3) development of new applications for existing technologies

The key word in both definitions is "Marketable"

RAND

The DoD SBIR goals, as stated, suffer from some degree of ambiguity. In particular, the meanings of "commercialization" and "innovation" are, on their face, subject to various interpretations. However, the SBA defines these two terms in its "Small Business Innovation Research Program Final Policy Directive." Commercialization is defined as:

The process of developing *marketable* products or services and producing and delivering products or services for sale (whether by the originating party or by others) to Government or commercial markets.³⁶

Innovation is defined as:

Something new or improved having *marketable* potential including (1) development of new technologies, (2) refinement of existing technologies, or (3) development of new applications for existing technologies.³⁷

³⁶ U.S. Small Business Administration (2002). Emphasis added.

³⁷ U.S. Small Business Administration (2002). Emphasis added.

What is significant in both definitions is the use of the term "marketable." While the SBIR Policy Directive does not define it, "marketable" implies that the SBIR program aims to sponsor projects that result in products, services, or technologies that are ready, or at least relatively close to ready, for sale. In terms of R&D phase, projects that result in "marketable" results are typically later-phase work rather than basic or applied research.

Current DoD SBIR Metrics

1. Stimulate Innovation

Current metrics measure only stimulation

1. Number of topics
2. Number of proposals
3. Number of Phase I and Phase II awards
4. Percentage of extramural R&D budget/dollars spent

Fiscal Year	DoD Component	SBIR Budget	# Topics	# Ph I Proposals	# Ph I Awards	# Ph II Awards
FY03	Army	169,002,000	243	3,884	352	324
	Navy	196,624,000	221	3,088	551	192
	Air Force	264,217,520	228	3,637	449	234
	DARPA	61,036,000	52	1,105	89	67
	DTRA	4,914,000	8	194	7	3
	MDA	129,122,450	102	1,861	454	184
	SOCOM	11,546,000	14	318	28	14
	CBD	9,070,000	20	349	25	10
	OSD	48,968,000	34	553	156	51
	NIMA	448,748	4	49	2	1
	All DoD	894,949,718	926	15,038	2,113	1,080

Source: DoD SBIR Annual Report Summary,
<http://www.dodsbir.net/annualreport/annrpt.html>

Innovation is not measured, but SBIR output (research reports and contractor information) is made accessible

RAND

The DoD SBIR program's first goal, to stimulate technological innovation, has two components. One is "stimulation," which is an input to the R&D process and relatively simple to measure. Stimulation in the DoD SBIR program is measured by counting the

- Number of topics included in each solicitation
- Number of proposals received
- Number of Phase I and II contracts awarded
- Dollars, both as a percentage of DoD's extramural R&D budget and in gross.

The other component of the SBIR program's first goal, "innovation," relates to the output of the R&D process and is more difficult to measure. To date, DoD has made no attempt to measure the SBIR program's impact on innovation. Instead, the DoD SBIR program ties final payment on each SBIR contract to the delivery of the project report. Compliance with this contract requirement and final payment act to ensure that project reports are filed and available to DoD's scientific community.

Additionally, DoD maintains a publicly available database of SBIR awards, awardees, and project abstracts. While this database does not provide the results of research performed with SBIR funding, it does provide a broader audience with information concerning topics researched and contact information for the small businesses that conducted the research.³⁸ These measures make it somewhat more likely that if innovative activity occurs within the SBIR program, DoD and others are made aware of it. They do not, however, guarantee or measure that enhancement.

³⁸ U.S. Department of Defense (2004f).

Current DoD SBIR Metrics

2. Increase Private-Sector Commercialization of Federal R&D

Source – Navy SBIR Success Stories; <http://www.navysbir.com/success.htm>

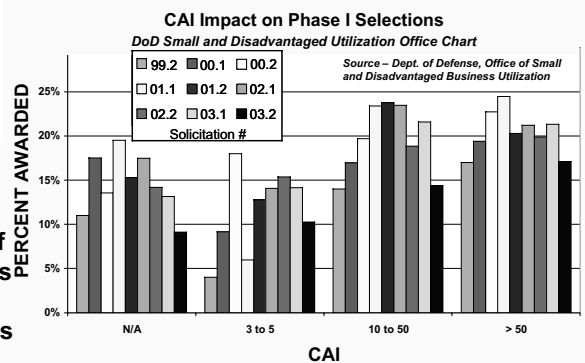
Miniaturized Antenna Array Phase III
Navy Topic#: AF00-246
Sponsor/Monitor:
NAVSYS Corp (Website)
14960 Woodcarver Rd, Colorado Springs, CO 80921
Charles Fay (Email)
719.481.4877

Success stories are only anecdotal evidence of SBIR program commercialization



The Commercialization Achievement Index (CAI) provides some measure of commercialization success and selection criteria for returning SBIR participants

RAND



As noted earlier, the SBA defines commercialization as “[t]he process of developing marketable products or services and producing and delivering products or services for sale (whether by the originating party or by others) to Government or commercial markets.”³⁹

Two methods for evaluating private-sector commercialization of SBIR research are currently used in the DoD “success stories” and the Commercialization Achievement Index (CAI). From the program’s inception until FY 2000, when Congress directed agencies to use a standard commercialization measure in proposal evaluation, anecdotal “success stories” were the only means by which policymakers could evaluate the impact SBIR had on private-sector commercialization. Through our interviews and review of “success stories,” we found that while they are compelling as testimony and provide interesting anecdotes, “success stories” are not a useful means of measuring the efficiency or

³⁹ U.S. Small Business Administration (2002).

effectiveness of the SBIR program since we could not find any way to use them for comparisons with other, analogous R&D investments.⁴⁰

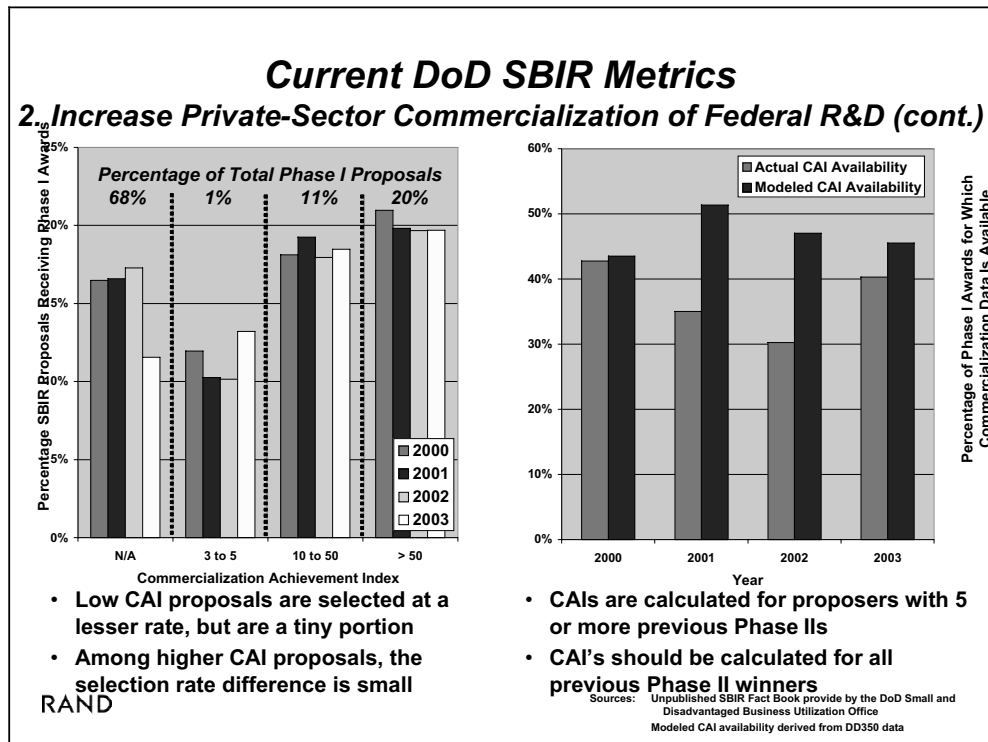
In the mid-1990s the DoD began collecting commercialization information from companies submitting SBIR proposals. Over several years this information was increasingly standardized and, in the late 1990s, resulted in a metric of commercialization success, the CAI.⁴¹ The CAI evaluates commercialization success on a scale from 0 to 100: the higher the CAI, the greater the commercialization success. Calculating the CAI requires that former SBIR winners self-report their success in commercializing their previous SBIR awards when they submit proposals in response to new SBIR solicitations. DoD then translates this self-reported data into a CAI for that proposal. The intent is to provide a simplified and standardized measure of past commercial success that can be used as an evaluation criterion for new proposals, as well as providing a measure of the SBIR program's success in commercializing federally funded R&D. CAIs were first calculated for proposals submitted in response to the second FY 1999 DoD SBIR solicitation. From then until the second solicitation of FY 2003 (the last data available at the time of this study), companies with CAIs less than or equal to 5 (again, on a scale of 0 to 100) were about 40 percent less likely to win a SBIR contract than companies with a CAI of greater than 5 were.⁴²

The development of the CAI indicates a move to improve measurement of commercialization beyond the use of "success stories." Nonetheless, as we discuss next, we found that the CAI cannot yet be used to evaluate the DoD SBIR program in terms of commercialization success.

⁴⁰ "Success stories" are collected in an ad hoc manner, use anecdotal evidence, and usually do not capture the spectrum of impacts SBIR has on participating firms or on DoD.

⁴¹ Development of the CAI was timely. Congressional direction in the 2000 SBIR Re-authorization Act (Public Law 106-554, Appendix I, Section 107) requires enhanced commercialization data collection.

⁴² CAI data from U.S. Department of Defense, 2004a.



From analysis of the data provided by OSD,⁴³ we found that the CAI is, at best, a weak predictor of whether a firm making a proposal for a

⁴³ For this study, we had access only to high-level CAI results, not the underlying data. Calculation of the CAI is straightforward. Each company submitting a proposal for a Phase I award is required to submit commercialization data from any previously won Phase II awards. Commercialization data consists of the sum of additional investment the company receives to develop the Phase II technology and any sales that result from the technology developed in Phase II. For companies that have received five or more Phase II awards, their mean commercialization success is compared with the mean commercialization success of a random sample of Phase II awards. The number of random Phase IIs that make up each sample is equal to the number of Phase II awards the currently proposing company has previously won. For example, if a company had previously won seven Phase IIs, each sample would consist of the commercialization data from seven randomly selected Phase IIs. A thousand of these random samples are generated to create a commercialization distribution. The proposing firm's CAI is then simply equal to the firm's position on commercialization distribution. For example, if the proposing firm's mean commercialization was greater than 70 percent of the random samples, its CAI would equal 70.

SBIR contract will win a contract.⁴⁴ This is because the absolute difference in award rate between the half of the companies with the highest CAIs and those with all but the very lowest scores is minimal. For example, over the four years that the CAI has been in effect, the average selection rate for proposers with CAIs between 10 and 50 (about a third of the proposers with CAIs) is approximately 19 percent. The rate for proposers with CAIs greater than 50 (about two-thirds of the proposers with CAIs) is only a percentage point greater. As noted previously, the selection rate for those proposers with the lowest reported CAIs (3 to 5) is significantly lower at 11 percent, but this category represents only 1 percent of all proposers and only 3 percent of proposers with CAIs.

CAIs are calculated only for companies that have won at least five Phase II awards. Consequently, CAI are not being assigned for all the Phase I awardees for which we would expect commercialization data to be available. This constraint is overly restrictive since it fails to measure the commercialization success of a significant portion of the SBIR awardee population for which commercialization data should be available. This portion of the SBIR awardee population could include some of the more interesting and important companies in the program—specifically those entrepreneurial companies that use the SBIR program as a source of capital early in their history but, as they gain business success, may go on to other funding sources after winning relatively few SBIR awards.⁴⁵ Instead of using the number of previous Phase IIs as a limitation on which proposers are required to submit

⁴⁴ Simple tests, such as the chi-square test, indicate that the CAI data are statistically significant.

⁴⁵ There are no data to support this supposition, but it follows from our understanding of the SBIR program. By this we mean that the technical merit of a proposal is usually the primary factor in making an SBIR award. This may mean that new entrepreneurs will turn to the SBIR program when most of what they have to offer in return for funding is a good idea and "sweat equity." Other sources of money for entrepreneurs with a good technical idea but little experience running a business or marketing a product are very limited. Venture capitalists and other financial institutions need to limit the risks on their investments. As a result, their decision process for extending resources places much more emphasis on the nontechnical aspects of turning a good idea into a valuable product or service.

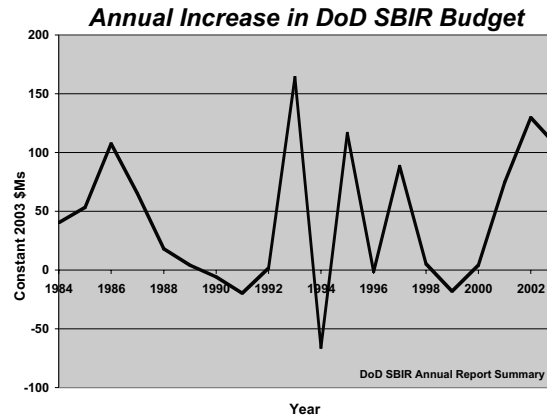
commercialization data, we recommend requiring all Phase I proposers that have been awarded one or more Phase IIs to be required to submit commercialization data for their previous Phase IIs. This requirement can be softened by exempting Phase II awards completed reasonably recently (e.g., within three years of the new Phase I proposal). We modeled CAI availability with such a criteria and compared that with actual CAI availability using the current criteria.⁴⁶ Based on our criteria, CAIs should be calculated for 40 to 50 percent of Phase I awards, which is significantly higher than the current calculated rate of 30 to 40 percent.

⁴⁶ We modeled Phase I CAI availability using the actual award data from the DD350 database. We assumed that a company competing for a Phase I award should be able to provide commercialization data if that same company had won at least one Phase II award five or more years prior to the current competition. The five-year assumption is very conservative. It is based on two years to complete the Phase II award and another three years to engage in other reportable commercialization activity. A less conservative assumption about the time needed for commercialization activity would yield greater differences between actual and modeled CAI availability.

Current DoD SBIR Metrics

3. Increase Small Business Participation in Federally Funded R&D

- **The DoD SBIR program has directed an increasing amount of R&D funding to small business**
 - Average \$43 million/year increase in SBIR budget
 - Total SBIR budget was ~ \$900 million in FY 2003
- **The DoD SBIR program has introduced small business to the defense market**
 - 34% of Phase I winners 2003 were first-time defense contractors



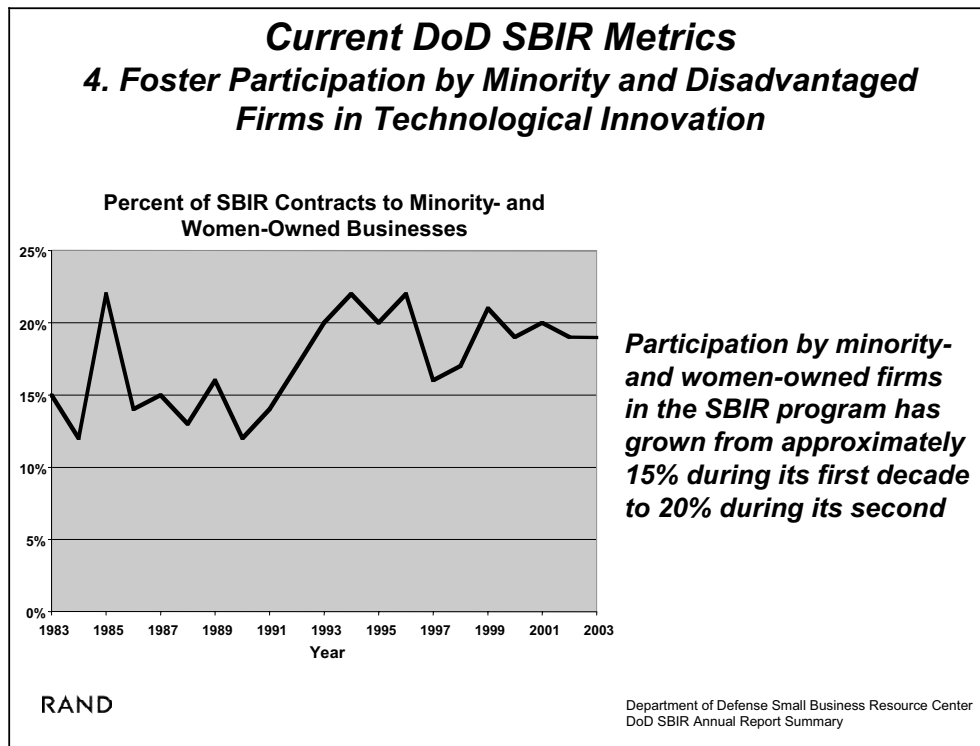
RAND

The DoD SBIR program goal of increasing small business participation in federally funded R&D can be measured by the dollars spent on the program. The current size of the DoD SBIR program, about \$1 billion per year, has been achieved through an average annual growth rate of about \$43 million per year for the past 20 years, as measured in constant 2003 dollars. Since the start of the program in the early 1980s, the DoD SBIR program has grown in every year but three.⁴⁷

Another way to assess the program's effectiveness with respect to this goal is to count the number of new contractors doing business with DoD as a result of the department's SBIR program. DoD tracks this statistic and most recently has claimed that a third of all Phase I winners were new to the DoD market.⁴⁸

⁴⁷ U.S. Department of Defense (2005a).

⁴⁸ U.S. Department of Defense (2004d).



DoD measures the goal of fostering participation by minority and disadvantaged firms in technological innovation by counting the number of firms claiming that status that won DoD SBIR contracts. The department maintains this metric as the absolute percentage of women and minority firms with contracts in its SBIR program and tracks that percentage over time. During the first half of the program, up until the early 1990s, women- and minority-owned companies generally won about 15 percent of DoD's SBIR contracts. The second half of the program experienced a marked increase to an average of about 20 percent of DoD SBIR firms claiming women or minority status.⁴⁹ While the percentage of women- and minority-owned participation has stayed relatively stable at 20 percent over the past few years, the SBIR program has continued to grow, indicating that the absolute number of women- and minority-owned firms participating in the program has been growing too.⁵⁰

⁴⁹ U.S. Department of Defense (2004d).

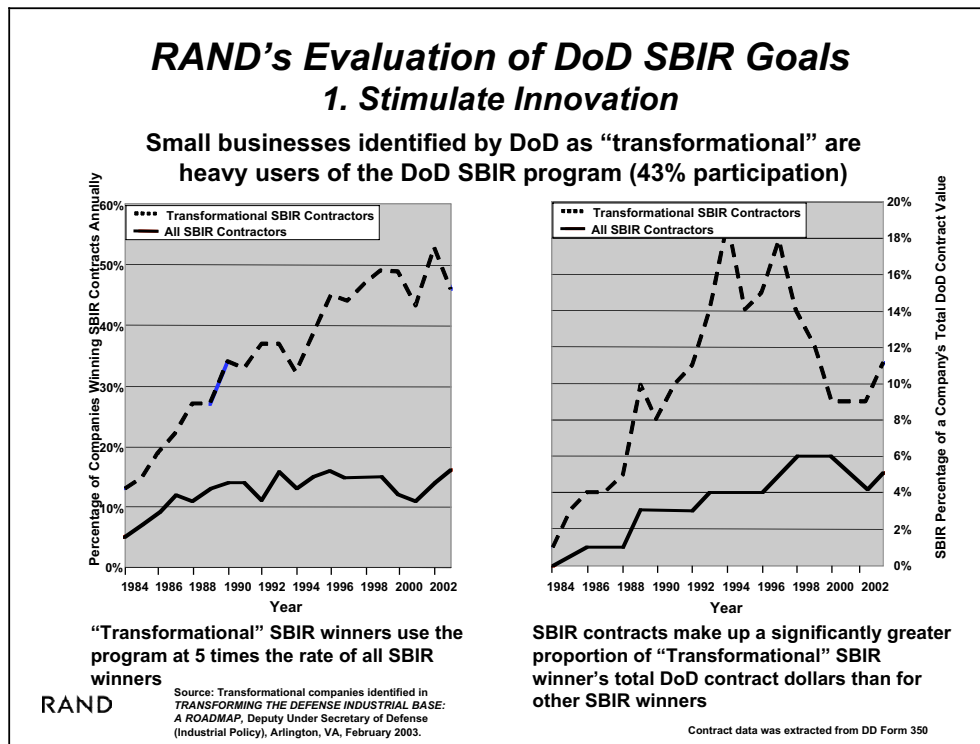
⁵⁰ This follows similar trends in federal contracting. The share of all federal contract actions to women-owned businesses also doubled between 1989 and 1995.

RAND'S EVALUATION OF CURRENT GOALS***Outline***

- DoD SBIR program and history
- **DoD SBIR goals and metrics**
 - DoD's evaluation of current goals
 - **RAND's evaluation of current goals**
- Other RAND findings
- Improving the DoD SBIR program
- **Conclusions**

RAND

We now turn to RAND's examination of how well the DoD SBIR program is accomplishing its stated goals.



As noted earlier, measuring innovation is not an easy task. We looked for indicators of whether the SBIR program is a stimulator of innovation and found several.

In 2003 the Office of the Deputy Under Secretary of Defense (Industrial Policy) published *Transforming the Defense Industrial Base: A Roadmap*.⁵¹ Appendix A of that document lists 383 companies identified as being "transformational," 257 of which were small businesses. Although the term "transformational" was undefined, we assume it to mean, among other things, that the companies were innovative to some extent. From the list of 257 "transformational" small businesses, we identified 110 (43 percent) that received one or more SBIR awards in the DD350 database.⁵² These SBIR-winning transformational companies were

⁵¹ U.S. Department of Defense (2003b).

⁵² DD Form 350 is the Individual Contracting Action Report. Every contract action with DoD, including SBIR contracts, with a value greater than \$25,000 (greater than \$2,500 in FY 2005 and later) is reported using this form. The information gathered on the DD350 is collected in a publicly available database (U.S. Department of Defense, 2005d). The data on these charts were derived from the DD350 data. Appendix A describes the DD350 database and our use of it.

then compared with the larger set of all SBIR-winning companies. For each set of companies (all SBIR winners and "transformational SBIR winners") and for each year since the beginning of the SBIR program, we calculated the percentage that won a SBIR award in the given year. For example, in 1990, 34 percent of the transformational companies received one or more SBIR contracts, compared with 14 percent of the larger set of SBIR winners. Indeed, since the start of the SBIR program, companies identified by OSD as transformational have consistently won substantially more SBIR contracts than the population of SBIR contract winners as a whole.⁵³

Additionally, the transformational companies have relied more on the SBIR program as a contracting mechanism with DoD than has the larger population of all SBIR winners. This fact is made clear by comparing the dollars each company won in DoD SBIR contracts with the total funding they received through all DoD contracts.

We infer two things from all this. First, because 43 percent of the DoD's "transformational" small businesses use the SBIR program and because that use constitutes a significant portion of their DoD contract dollars (9-18 percent over the past decade), this suggests that DoD is using its SBIR program, to some extent, as a resource to fund a significant percentage of its small business, transformational R&D. Second, both the substantial use of the SBIR program by "transformational companies" and their overall reliance on the program as a contracting mechanism for DoD work provide some indication, although perhaps only a weak one, that the SBIR program is funding innovation that the department considers important.

⁵³ Authors of the report from which the list of "transformational" firms was identified used lists of recent SBIR winners as one of their sources. This introduces a significant potential for referential bias into the results of our analysis. We continue to include the results because a selection process for "transformational" companies was still required. "Transformational" remains in the eye of the DoD beholder, thus noting the extent to which the SBIR program is important to these companies is important.

***RAND Measures of DoD SBIR Goals:
1. Stimulate Innovation (cont.)***

- **Case studies of DoD SBIR award winners**
 - **Class of 1995**
 - **First DoD contract is a SBIR Phase I in 1995**
 - **Random sample of 40 companies**
 - **Quick look at publicly available information**

Some indicators of innovative activity are evident

- **SBIR plays a role in high-tech start-ups**
 - **15 of the class were founded in 1993 or later**
 - **Half were founded since 1990**
- **31 patents among companies started in 1993 or later**

RAND

To gain a better understanding of how well the SBIR program stimulates innovation we also conducted an analysis of a random sample of 40 SBIR winners. Due to the resource limitations of this study, the analysis was relatively limited, but it provides some indication of the importance of the SBIR program for generating technological innovation. The 40 companies were selected randomly from the list of companies that won their first DoD SBIR contract in 1995.⁵⁴ We collected information on 39 of the 40 firms in the random sample using Google searches on the Internet, queries of the Central Contract Registration database, examination of the TECH-Net database, and materials from the U.S. Patent

⁵⁴ We chose 1995 as our test year for two reasons related to data integrity. First, starting with the 1990 data, we corrected the DD350 database to identify each SBIR company as a single entity, regardless of the use of differing identifiers for the same company throughout the database. We assumed that if a company had not won a DoD contract of any kind in FY 1990 through FY 1994 (five years), it was unlikely to have won a DoD SBIR award prior to 1990, thus making it a first-time contractor for the department. Second, we wanted to examine companies that had enough time since their first SBIR contract to further develop the results of the SBIR project, as well as to develop the company itself. Appendix B is an expanded explanation of the 40 case studies.

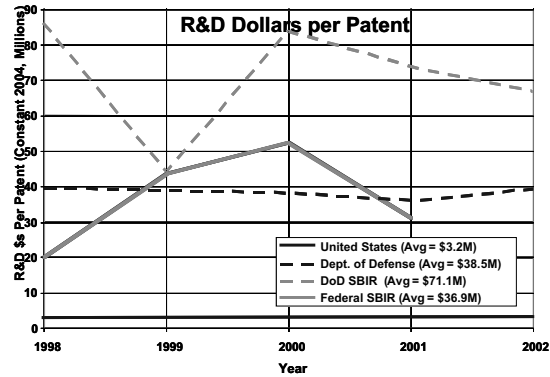
and Trademark Office (USPTO).⁵⁵ For 28 companies, we verified a date of founding, either through the company's Web site or using the Central Contract Registration database. Of these 28, 15 were founded in 1993 or later, and fully half were founded since 1990. Since new companies are often lacking in financial resources, it seems safe to assume that SBIR funding provided a significant portion of the revenue for at least some of the new companies.⁵⁶ The immaturity of such a large portion of these companies leads us to speculate that the SBIR program may have played a material part in the development of technology by a significant percentage of these firms. In addition, the 15 companies founded in 1993 or later have generated 31 patents. As a result, this analysis provides some indication, although far from conclusive evidence, that the DoD program may have stimulated the creation of technology-based businesses, while the patent generation by these firms is evidence of innovative activity.

⁵⁵ One company was eliminated from the sample because it was misnamed in the database and should not have been part of the class of 1995.

⁵⁶ During the course of this research, we talked to the founders of four of the companies that were founded after 1990. Two of these are still active companies and are discussed later. One is no longer in business, and the other is currently a single-person consultancy. In each case, the company founders confirmed that SBIR funding provided a significant portion of their revenue early in the company's history.

RAND Measures of DoD SBIR Goals: Stimulate Innovation (cont.)

- The SBIR program has resulted in patenting activity
 - 304 total SBIR patents
 - 81 (27%) DoD-specific SBIR patents
- Patenting costs (\$/patent) in the SBIR program appear high, particularly in DoD
 - Reporting may partly explain a low SBIR patenting rate
 - There may be other reasons companies do not patent SBIR-related inventions



Patenting costs were obtained by dividing R&D costs by # of patents. R&D costs are:
 1. U.S. R&D spending estimates - National Science Board, Science and Engineering Indicators - 2004
 2. DoD R&D budget - National Defense Budget Estimates for FY 2004
 3. Federal SBIR budget - SBIR Program Statistics <http://www.sba.gov/sbir/indexsbirstr.html#sbirstats>
 4. DoD SBIR budget - DoD SBIR Annual Report Summary
 Patent numbers were obtained from the U.S. Patent and Trademark Office, <http://www.USPTO.gov>

RAND

In our search for indicators of innovation from the DoD SBIR program we looked more closely at one of the standard surrogates for measuring innovation: patenting. USPTO's patent database includes a searchable data field that includes a SBIR identifier. A search of this field for "small business innovation research" or "SBIR"⁵⁷ reveals 304 patents declared by SBIR participants as resulting from SBIR awards. Only about one-quarter (81) of these patents were from DoD SBIR firms. The fact that DoD awarded about half of all SBIR dollars suggests that the DoD SBIR program may be less efficient on a R&D expenditure per patent basis than the broader federal SBIR program is in terms of patenting.⁵⁸ In addition, the DoD SBIR patenting cost (dollars per

⁵⁷ Searches performed on the USPTO database at USPTO.gov were (a) GOVT/((sbir OR "small business innovation research"), (b) GOVT/((sbir OR "small business innovation research") AND (((("NAVY" OR "naval") OR "Air Force") OR "Army") OR "Defense") OR "MDA") OR "SOCOM") OR "DARPA"). Search run on January 4, 2005.

⁵⁸ Patenting costs were obtained by taking the number of patents identified as either only SBIR or as SBIR qualified with a defense interest and dividing by the cost of either the federal SBIR program or the DoD SBIR program. Costs were converted to constant 2004 dollars.

patent) appears higher than for defense R&D program overall.⁵⁹ Compared with the overall U.S. average patenting cost, the DoD SBIR program appears to be 20 times higher.⁶⁰

However, the patenting data presented here are only a potential indicator of innovation activity. There are a number of reasons the DoD SBIR program may appear to have high patenting costs but may nevertheless spur innovation. First, and most obviously, the data used to calculate patenting cost are subject to reporting problems. Identifying a patent as related either to SBIRs or to defense is, to a large degree, a matter left to the discretion of the patent applicant. Moreover, our search of the database may not have been as effective as we would have liked, given our time and resource constraints.⁶¹ It may also be the case that a company or individual would, for some reason, be more disinclined to patent the results of SBIR-related research than research funded by other means. Finally, patenting is only a surrogate measure of innovation. Many truly innovative ideas and inventions are never patented, while many more mundane concepts bear a patent. Nevertheless, the patenting data may be indicative.

The DoD SBIR program has resulted in a number of patents and, hence, presumably has resulted in some innovation activity. A review of patenting costs, however, provides a hint that the DoD SBIR program may not be as effective or efficient at generating innovative activity as other R&D funding mechanisms or, alternatively, getting credit for that activity.

⁵⁹ General defense patenting costs were obtained by dividing DoD's R&D budget (in constant 2004 dollars) by the number of defense interest patents (U.S. Department of Defense, 2003c).

⁶⁰ Overall U.S. patenting costs were obtained by dividing the total number of U.S. patents in a given year, as provided by USPTO and by the U.S. R&D spending estimates published by the National Science Board (U.S. National Science Board, 2004).

⁶¹ For example, a more rigorous search of patenting would have examined all patents related to the companies in our sample and looked for similarities and connections between the invention descriptions and the SBIR topics and award abstracts.

RAND Measures of DoD SBIR Goals:

Increase Private-Sector Commercialization of Federal R&D

- **Random sample of 40 DoD first-timers (1995 DoD SBIR Class)**
 - **18 companies (45%) still in business or merged/acquired**
 - **At least two commercial successes that appear tied to SBIR awards**
 - Active and adaptive optical devices by Xinetics Inc.
 - Software Security by Reliable Software Technologies (now Cigital)

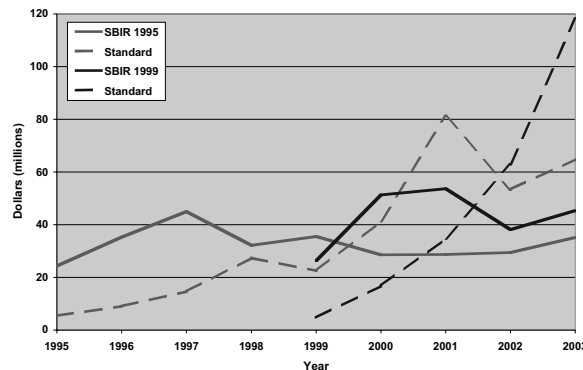
- **Cumulative DoD contracting that started with SBIR**

1995 - \$319M Non-SBIR

- \$292M SBIR

1999 - \$237M Non-SBIR

- \$215M SBIR



RAND

Contract data were extracted from DD Form 350,
<http://web1.whs.osd.mil/peidhome/guide/proccoper.htm>

**History of First-Time DoD Contractors That
Start with an SBIR Phase I**

In our analysis of the random sample of the SBIR class of 1995, we looked for indications that the SBIR program played a role in creating a commercially viable product or company. We determined that 14 of the 40 sampled companies were still in business and that four had merged with or were acquired by another company.⁶² Of these 18 companies, two reported that SBIR played a significant role in the early stage funding that led to their later commercial success.

The first company, Xinetics Inc. of Devens, Massachusetts, was founded in 1993 to develop precision motion control products. After winning its first SBIR award in 1995, Xinetics won ten more Phase I

⁶² This survival rate is reasonably consistent with new business survival rates generally. The Bureau of Labor Statistics reports that 44 percent of all new firms started in the second quarter of 1998 were still in business four years later (U.S. Department of Labor, 2005). Similarly, a study for the U.S. Small Business Administration found that 50 percent of all new businesses started between 1989 and 1992 survived for four years and that 40 percent survived for six years (Headd, 2001). These business survival rates are slightly higher than for our sample of 40 SBIR companies; however, our analysis examined a longer, ten-year period.

awards and eight Phase II awards. A cofounder of Xinetics, Mark Early, reports that the SBIR program provided resources to support high-risk, militarily critical research when other financing was unavailable. He also notes that the results of the research conducted as part of the SBIR program found their way into a number of Xinetics products and have helped Xinetics achieve success with both government and commercial customers. Early claims that the SBIR support helped Xinetics develop technology needed by some defense prime contractors and, perhaps as importantly, that the SBIR program helped Xinetics develop as a business such that the prime contractors gained confidence in the company's ability to deliver.⁶³

Reliable Software Technologies, now Cigital, is a software security and reliability firm in Dulles, Virginia. Founded in 1992, Cigital was cited by *Inc.* in 2000 as one of the 500 fastest growing small companies in the United States.⁶⁴ The company has successfully tapped the DoD market with nearly \$8 million in non-SBIR DoD contracts since 1995, and its revenue in 2003 totaled \$8.7 million. Additionally, Cigital has acquired \$5 million in venture capital money since 2002.⁶⁵ While the firm won its first DoD SBIR award in 1995, it had already won several SBIR awards from NASA starting in 1992. Jeffrey Payne, the president and chief executive officer of Cigital, reports that these early SBIR awards launched his company, provided the track record and expertise necessary for significant follow-on government contracting, and made it possible for the company to develop its commercial products and services.⁶⁶

Another commercialization issue in the DoD context is whether companies that use the SBIR program to enter the DoD market mature enough to attract DoD contracts funded with non-SBIR contracting vehicles. To evaluate SBIR companies' success in becoming non-SBIR DoD contractors we used two sets of companies: those that won their first

⁶³ During the mid-1990s the SBIR program funded high-risk research on deformable mirrors that are now integrated into the Airborne Laser system (Mark Early, telephone communication with author Thomas Edison, January 6, 2004).

⁶⁴ *Inc.* Staff (2005).

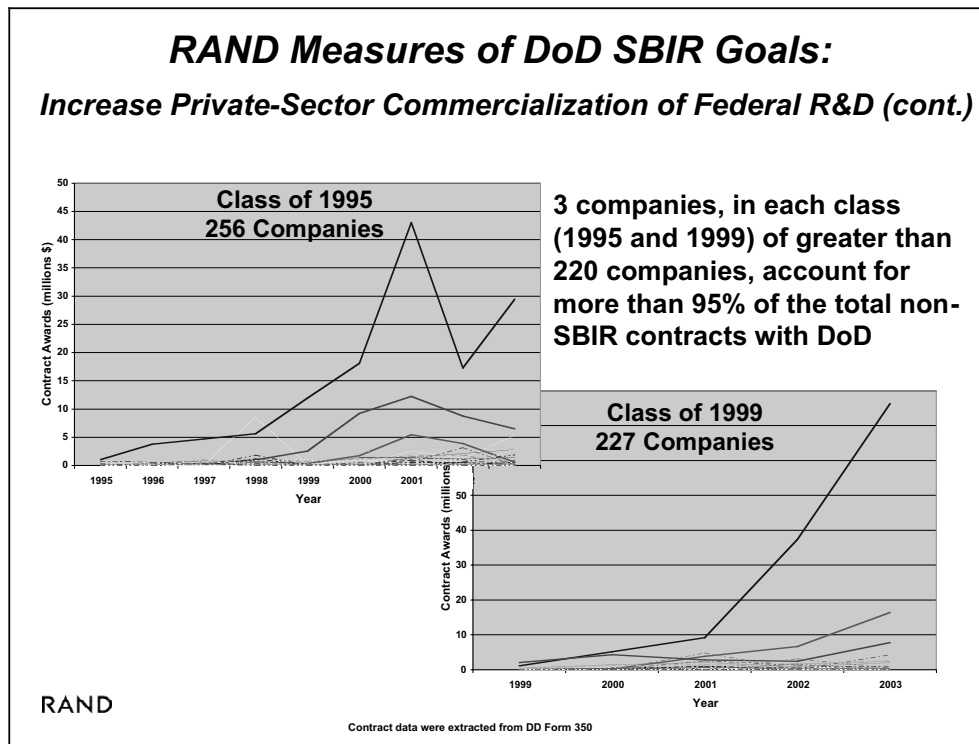
⁶⁵ Yahoo! Finance (2005).

⁶⁶ Jeffery Payne, email to author Thomas Edison concerning the role of SBIR in Cigital's development, December 10, 2004.

DoD contract in 1995 (the same class used earlier) and those that won their first DoD contract in 1999.⁶⁷ For these two sets we identified the dollar value of their DoD contracting in every year through FY 2003, as a whole and by individual company. Each of these sets shows an increase in the amount of non-SBIR DoD contracting over time⁶⁸ and, beginning several years after the founding year for each set, the non-SBIR contract dollars exceed the SBIR dollars in each subsequent year. For both sets the cumulative funding associated with non-SBIR contracting is about 10 percent greater than their total funding from SBIR contracts. This increase suggests some success in introducing small businesses to the broader DoD market through the SBIR program. However, as the next slide shows, further analysis at the company level tempers that hypothesis.

⁶⁷ We examined the classes of 1995 and 1999 in detail as representative classes that entered the DoD market approximately five and ten years prior to our study.

⁶⁸ Non-SBIR contracts included all DoD contracts, including SBIR Phase III awards, going to companies belonging to the classes of 1995 and 1999 that were not identified as Phase I or Phase II SBIR awards in the DD350 database.



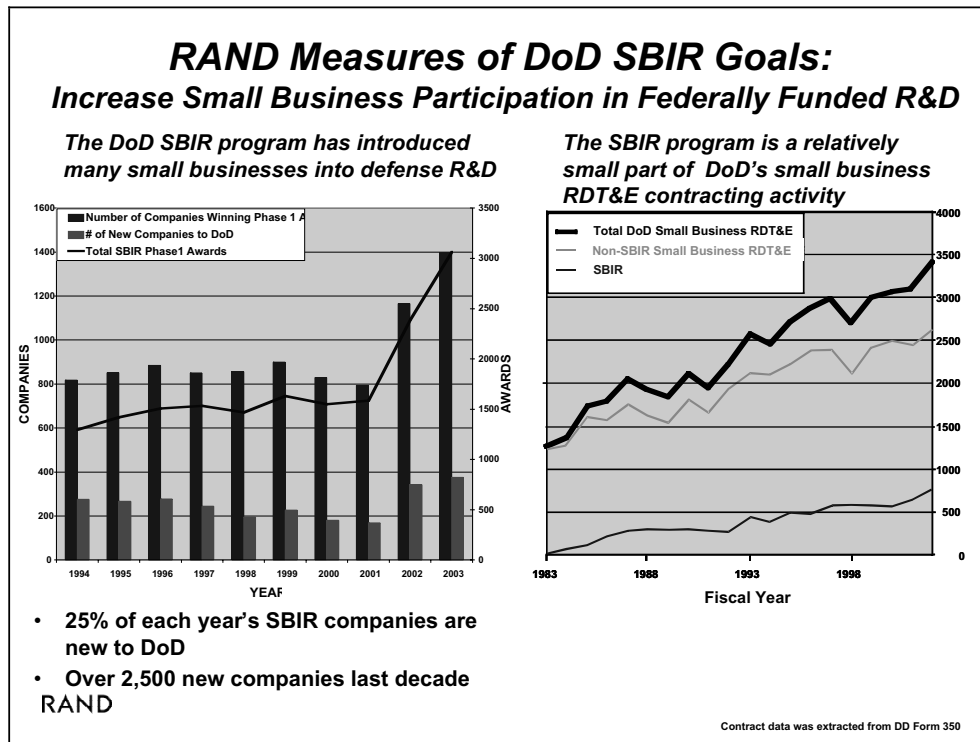
When the value of the DoD non-SBIR contracting is plotted by individual company, a somewhat different story emerges. The previously cited rise in non-SBIR contracting was generated by significant successes in only a very small number of companies. For example, each of the class of 1995 and 1999 includes more than 225 companies. In both classes, fewer than ten companies account for the bulk of non-SBIR contracting achieved in later years.⁶⁹ In fact, in both classes, only three companies are responsible for more than 95 percent of the non-SBIR DoD contracting that occurred after the beginning of the class.⁷⁰

⁶⁹ For the class of 1995 in 2003, 20 percent of the companies had a SBIR contract action associated with it, 13 percent had a non-SBIR contract action. Of these, 9 percent of the total had both types of contract actions. For the class of 1999, the percentages are 37 percent, 17 percent, and 9 percent, respectively.

⁷⁰ Class of 1995: *Darlington Inc.* specializes in command and control technology; it was acquired by EDO in 2003 for \$28.5 million. *Chesapeake Sciences Corporation* specializes in sonar telemetry and data acquisition products. *X-ray & Specialty Instruments* manufactures custom and stock x-ray tubes and x-ray image intensifiers. Class of 1999: *Chenega Technology Services Corporation* is an 8(a) Alaska Native Corporation (ANC) that provides support services to the military.

Whether the few companies that achieved DoD contracting success beyond the SBIR contracts would have done so without the SBIR program is unknown. As importantly, the extent to which SBIR award winners graduate to become subcontractors to DoD prime contractors is also unknown. How well the DoD SBIR program introduces small businesses to the defense industrial base should be a topic for future study.

(ANCs receive additional advantages in federal contracting. For example, most 8(a) contractors are limited in the size of non-competitively won contracts they may receive. ANC-certified 8[a] contractors have no limit on the size of non-competitive federal contracting awards [13 CFR 124.506]). *Radiance Technologies* is a software company that specializes in managing the transmission of digital information. *CMS Technetronics* (now Sciperio) is a general R&D company.



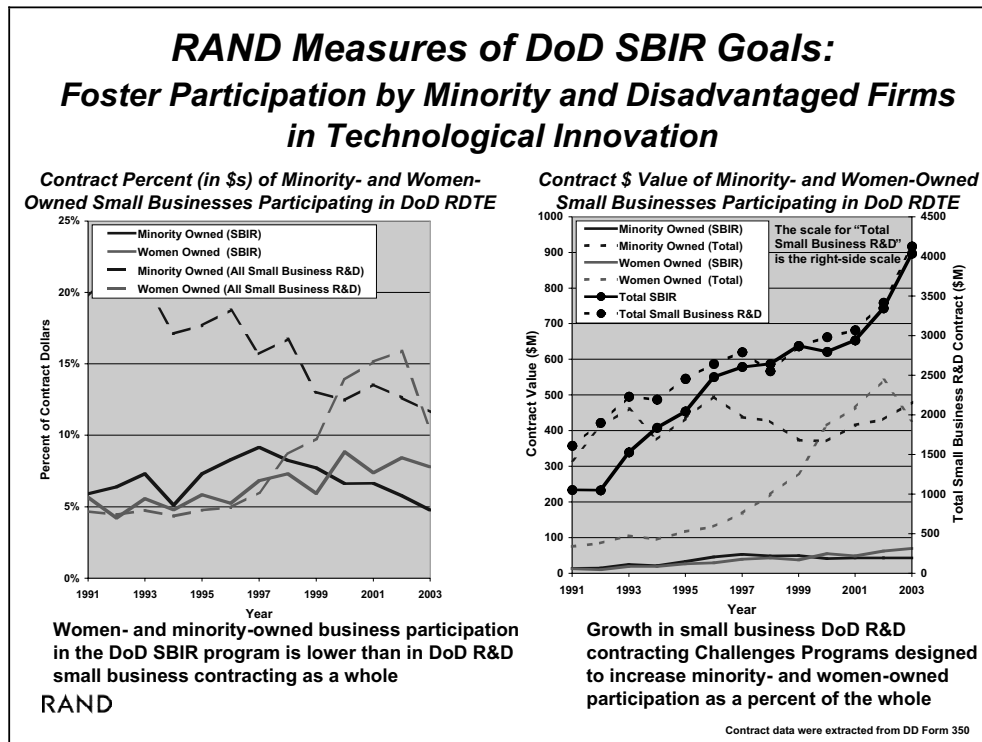
Over the past decade, more than 800 small businesses have participated in the DoD SBIR program each year. Recently, as the program's budget has increased, the number of businesses awarded SBIR contracts has swollen. In FY 2003 alone, about 1,400 small businesses participated. More importantly, the DoD SBIR program has provided a means for small businesses that had previously not done business with the department to compete for and win defense RDT&E contracts. Businesses new to defense contracting have made up roughly one-quarter of all businesses involved in the DoD SBIR program over the past ten years. In all, more than 2,500 small businesses have used the SBIR program to gain entry to the DoD market; thus, the SBIR program has provided a significant opportunity for small businesses participation in federal R&D.⁷¹

⁷¹ The DD350 data we used in this research included contracts from FY 1990 through FY 2003 for more than 5,575 different SBIR award winners (14 years of contract data). We assumed that a company was new to DoD contracting if it was awarded a contract during or after FY 1994 and had not contracted with DoD during the four-year period from 1990 to 1993.

This assessment must be qualified to some extent, though. As noted previously, the number of new firms that continue to do business directly with DoD, over the long term and outside the SBIR program, is small. Additionally, the SBIR program is only a part of DoD's RDT&E contracting activity with small businesses. In FY 2003, nearly \$3.5 billion in DoD RDT&E dollars went to small businesses, with about \$0.9 billion, or 25 percent, of those dollars being part of the SBIR program.⁷²

We checked this assumption by examining the number of companies in our DD350 database of SBIR contractors that had a break between DoD contract awards for a number of years. 4.6 percent of these companies had a break of at least four years between DoD contract awards. This percentage declined as a function of the length of the DoD contract award hiatus and no contractors during this 14-year period had a break of nine years or more. As a result, we concluded that our data concerning new contractors is reasonable. For 1994, the new contractor data may be overestimated by about 5 percent and by about 2.5 percent in 1995. After that, the error should be 1 percent or less.

⁷² The DD350 database identifies whether a contractor is a small business and whether the contract is for R&D.



Since the goal of fostering disadvantaged- and minority-owned business participation in DoD RDT&E is general and sets no specific targets, we sought a comparison to provide insight into how well this goal is being met. DD350 data identifies contracts with minority- and women-owned business, providing the basis for the comparison. Contract dollars offer an accurate measure of participation. The percentage, in dollar terms, of minority- and women-owned small business participation in the DoD SBIR program can be compared with the percentage, in dollar terms, of minority- and women-owned small business participation among all small business DoD RDT&E contracts.

Significantly, we found that the DoD SBIR program has a lower participation rate for minority- and women-owned businesses than among the larger set of all small businesses with DoD RDT&E contracts. This result is, perhaps, not surprising. There are programs designed specifically to encourage small disadvantaged business participation in

government contracting that the DoD SBIR program does not use.⁷³ Since the DoD SBIR program is run competitively, the program may have more difficulty attracting small disadvantaged businesses.

⁷³ The primary program that encourages small disadvantaged businesses to contract with the federal government is the "8(a)" program. The SBA notes that the "8(a) Program offers a broad scope of assistance to socially and economically disadvantaged firms." Details of this assistance can be found at U.S. Small Business Administration (2005a).

Assessment of the DoD SBIR Program Against the Current Goals

- **Program \$s provide innovation stimulus**
 - Measuring actual innovation is more difficult, though some indicators of innovation are present
- **Some commercialization activity is apparent**
 - Success appears limited to a small percentage of participating companies
- **The DoD SBIR program increases small business participation in federally funded R&D**
- **The DoD SBIR program fosters participation by minority and disadvantaged firms in technological innovation**
 - However, other DoD R&D programs have more success contracting with small minority and disadvantaged companies

The DoD SBIR program generally complies with legislative goals, though determining overall effectiveness is difficult

RAND

Based on both the DoD's own measures and this study's examination of the available data, we conclude that the DoD SBIR program appears to be accomplishing the goals set out in the program's enabling legislation. The program's money is spent on R&D contracts with small businesses, hence "stimulating" innovation. On the output side of the R&D process, we noted that companies identified as "transformational" take greater advantage of the SBIR program and that there is some level of patenting activity, directly and indirectly, associated with the program, although the cost (dollars per patent) of patenting is probably higher in the DoD SBIR program than in other DoD R&D programs or more generally across the United States as a whole.

Some commercialization of federal R&D appears to be linked to the SBIR program. However, the limited information available indicates that commercialization as a result of SBIR-funded research is concentrated in just a few companies.

The DoD SBIR program clearly attracts a large number of small businesses to the DoD R&D market. Absent the requirement to spend a

fraction of total extramural R&D money with small businesses, DoD would presumably spend it like the rest of its R&D money, with large percentages going to organic DoD activities and to larger contractors. Importantly, the SBIR program has introduced, on average, roughly 250 new contractors to DoD each year, and in the past couple of years that number has been closer to 400.

The SBIR program also provides opportunity for minority- and women-owned small businesses to contract with DoD, although the SBIR program is not as effective as other DoD R&D programs in this aspect of contracting. The rate at which DoD spends money with these contractors is significantly lower in the SBIR program than in other DoD R&D contracts going to small businesses.

OTHER RAND FINDINGS***Outline***

- DoD SBIR program and history
- DoD SBIR goals and metrics
 - DoD's evaluation of current goals
 - RAND's evaluation of current goals
- **Other RAND findings**
- Improving the DoD SBIR program
- Conclusions

RAND

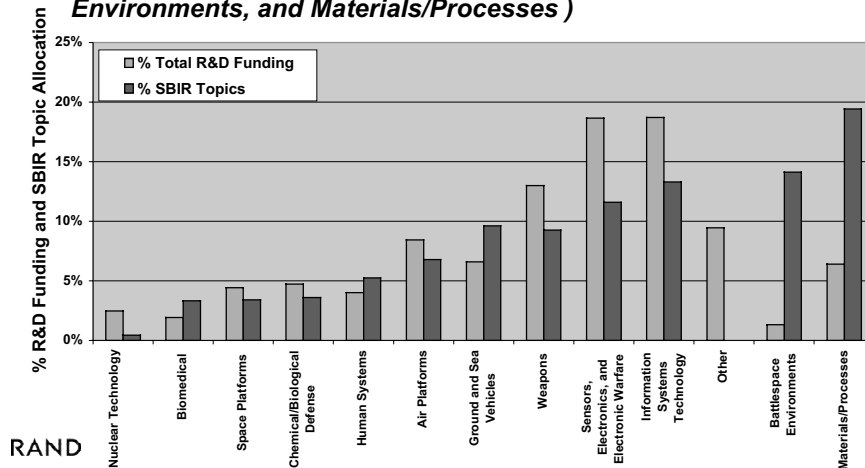
The previous two sections of this briefing examined information and measures about the DoD SBIR program that could be related to the goals set out for the program in the enabling legislation. In this section we examine additional information to gain insight into the broader character and effectiveness of the program. Our hope is that this broader examination will offer insights to help provide understanding of how policy actions could make the program more effective.

Specifically, we were interested in learning more about several issues. First, we wanted to understand whether the SBIR program supported DoD's R&D priorities. To answer this, we examined the SBIR topic generation process and also looked at how SBIR projects are allocated in the R&D process. We also recognized early in the study that any discussion of the SBIR program invariably includes questions about the role of companies that win numerous SBIR awards and appear to be "in the business" of conducting SBIR projects. Finally, we needed to understand how DoD funds the administration of the SBIR program. Since

DoD is not allowed to use any of the 2.5 percent of extramural department R&D funding that is taxed for the SBIR program, we were concerned that there may be insufficient administrative funding.

Broader RAND Findings: Topic Generation Is Reasonable

- DoD SBIR topic areas generally correlate with the RDT&E budget, indicating the program is responsive to the department's priorities
- The significant deviations that do exist between SBIR topic areas and the RDTE budget seem reasonable (*Other, Battlespace Environments, and Materials/Processes*)



To determine how SBIR priorities compared with broader DoD RDT&E priorities, we mapped the 983 SBIR topics in the four 2004 solicitations to the 12 Defense Technology Area Plan (DTAP)⁷⁴ areas listed in the SBIR topic description.⁷⁵ In particular, we used the percentages of R&D funding allocation described in the DTAP as an indicator of DoD's technology prioritization and compared them with the percentages of SBIR topics included in each technology area.

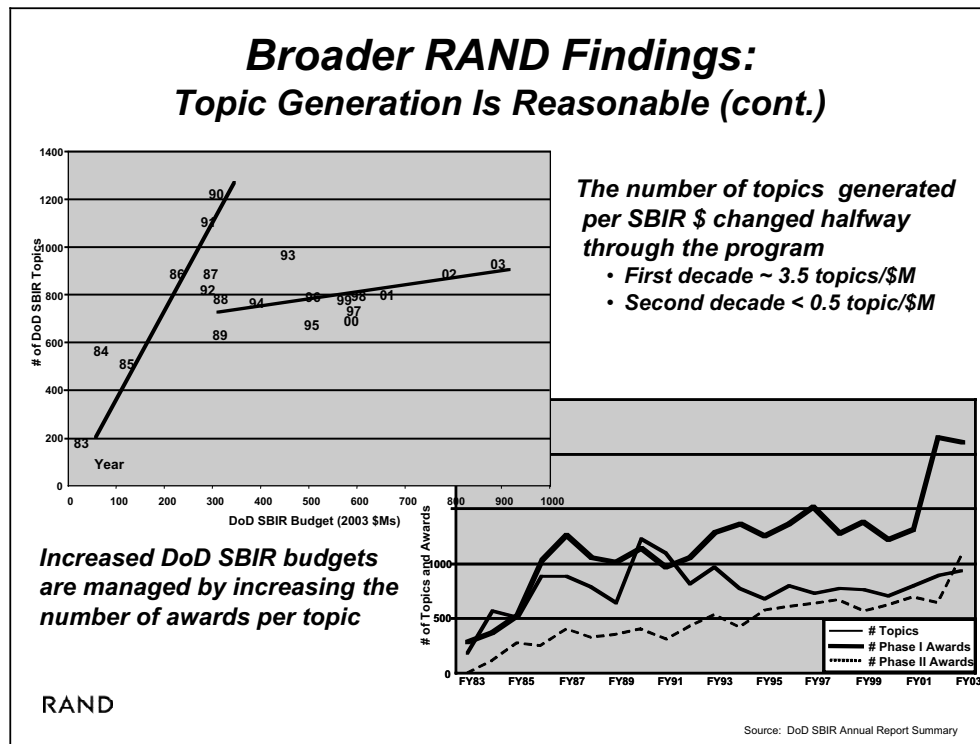
We found that, in general, SBIR topic allocation aligned well with the overall defense R&D budget allocations. For all but three topic areas, the difference between the budget allocation and the topic allocation was less than eight absolute percentage points. There were no topics allocated to a catchall category such as "Other" because we were able to generally assign each topic area to one of the specified funding areas. Two topic areas, "Battlespace Environments" and "Materials/Processes," had a significantly greater percentage of topics

⁷⁴ U.S. Department of Defense (2003a).

⁷⁵ Appendix E provides a listing of DoD SBIR topics contained in the 2004.3 DoD SBIR Solicitation.

allocated than overall RDT&E funding did—14 percent vs. 1 percent and 19 percent vs. 4 percent respectively—but these appear to be reasonable. Battlespace Environments is a topic area that seems especially appropriate for the SBIR program in that it involves research that is not capital intensive, such as computer simulation, and is hence more affordable for small business. As for Materials/Processes, in early 2004, the President issued Executive Order 13329 directing that the overall federal SBIR and STTR programs emphasize manufacturing-related research.⁷⁶ Projects undertaken in response to the executive order should appear disproportionately in the Materials/Processes topic area, which indeed appears to have happened.

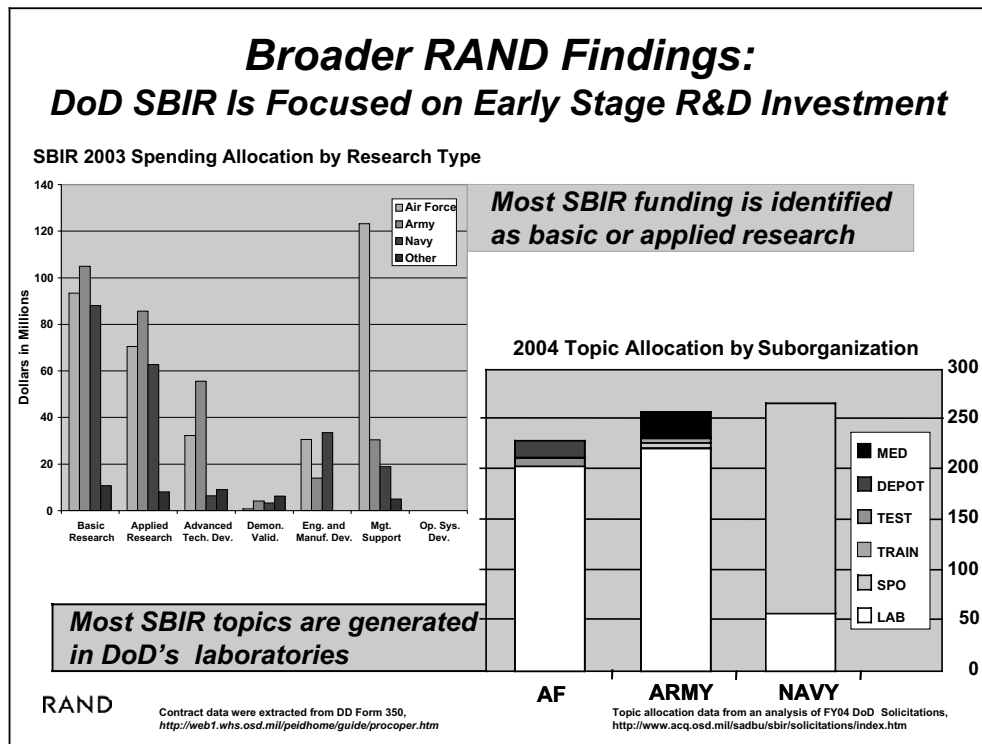
⁷⁶ President of the United States (2004).



As we have already shown, the DoD SBIR budget has grown dramatically over the past two decades. The rate at which topics are generated also changed to accommodate this growth. Over roughly the first half of the SBIR program DoD added approximately three-and-a-half topics for every additional million dollars of budget. Such growth in topic generation could not be sustained, particularly given a desire to keep down the cost of managing the program. As a result, the number of topics has grown more slowly over the past ten years. Instead of adding three-and-a-half topics per million dollars of SBIR budget, topics are now added at less than 0.5 topics per million dollars.

Absorbing an increasing budget while reducing the number of topics per dollar of budget required a change in the way awards were made. Indeed, the number of Phase I and Phase II awards per topic has increased over the course of the program—dramatically since FY 2001. This increase has allowed DoD to continue managing the SBIR process efficiently while maintaining the statutory commitment of 2.5 percent of extramural R&D budget to the SBIR program.

Understanding the topic generation and allocation process is not enough to fully inform as to whether the SBIR program supports DoD's R&D needs. It is also important to understand where SBIR projects are placed in the R&D process itself.



The DD350 form includes a classification for R&D contracts as either basic research, applied research, advanced technology development, demonstration/validation, engineering and manufacturing development, or management support.⁷⁷ SBIR dollars are not earmarked for any particular R&D budgeting category, but the fact that budget managers or reporting contracts officers are assigning SBIR contracts to a particular budget slot provides some indication of how the SBIR program is allocated. The Air Force's large amount earmarked for management support appears to be the exception.⁷⁸ That aside, SBIR program funds are clearly skewed toward basic and applied research, which accounts for almost 60 percent of the SBIR contracts. Assuming that the large amount identified as management support is actually proportioned like the rest

⁷⁷ These categories align with how DoD's R&D budget is allocated.

⁷⁸ The study team was told that the Air Force used the "Management Support" category as a convenient accounting bin for some of its SBIR funds. This money is not used for SBIR management but rather is allocated to SBIR contracts (Thomas J. Bond, DoD SBIR/STTR Program Administrator, Office of the Under Secretary of Defense [Acquisition, Technology and Logistics], Office of Small and Disadvantaged Business Utilization, communication with author Bruce Held, October 5, 2004).

of the SBIR program, basic and applied research makes up a bit less than three-quarters of the SBIR program, and no SBIR funds were allocated to Operational Systems Development.⁷⁹

We analyzed a recent SBIR solicitation⁸⁰ to count the number of topics generated by different offices within the Air Force, Army, and Navy. We categorized the offices as MED (medical laboratory), DEPOT (depot-level repair facility), TEST (test facility), TRAIN (training organization), SPO (systems program office), or LAB (research laboratory). We found that the Air Force and Army generated the majority of topics in laboratories. The Navy generates the majority of its topics by such program offices as Space and Naval Warfare Systems Command and the Naval Air Systems Command. The different allocation of the Navy topics to program offices reflects a different emphasis of SBIR in the acquisition cycle or a different philosophy for organizing acquisition programs within the services.⁸¹ Even including the Navy's greater use of program offices in topic generation, the services show a strong inclination to generate topics in their laboratories and R&D centers, thus supporting the DD350 analysis that identifies the majority of SBIR topics as focused on basic and applied research.

The allocation of SBIR topics and funds toward basic and applied research seems to conflict with the commercialization goal of the program. Among the findings of this study, we have found this particular one to be among the most controversial. Even when generally acknowledged as a valid finding, many people, both inside and outside DoD, have disputed the notion that the DoD SBIR program should allocate fewer

⁷⁹ The allocation of SBIR contracts across R&D categories contrasts with the allocation of DoD's overall RDT&E budget in FY 2003. DoD's allocation puts more than half of the RDT&E budget into Demonstration/Validation (23 percent) and Engineering and Manufacturing Development (30 percent). Basic Research (3 percent), Applied Research (8 percent), and Advanced Technology Development (10 percent) account for only a fifth of the total R&D budget. The remainder of the RDT&E budget is allocated to Management Support (6 percent) and Operational Systems Development (19 percent) (U.S. Department of Defense, 2002a).

⁸⁰ This analysis used the 2004.3 solicitation (U.S. Department of Defense, 2004b).

⁸¹ This different philosophy was confirmed in interviews with Navy SBIR personnel (Vinney Schaper, Office of Naval Research, interview with author Philip Antón et al., March 23, 2004).

resources toward basic and applied research. Reasons provided to us for maintaining the current allocation of topics and DoD SBIR funds include suggestions that the program is best structured for early phase research, the paucity of other DoD funds for basic and applied research (see footnote 88), and the general decline of funding for basic and applied research across the United States. For the purposes of this report, we cannot comment on the validity of these claims. Instead, we reiterate that Congress specified commercialization as a goal of the SBIR program and has, in fact, emphasized this goal in the last two reauthorizations of the program. An emphasis on basic and applied research during program execution seems, therefore, inappropriate.

***Broader RAND Findings:
DoD Use of SBIR***

- **Statutory Compliance**
- **Supplement organic DoD research efforts**
- **Move R&D dollars into priority technology efforts**
- **Create innovative solution to pressing operational need**
- **Supplement program office acquisition efforts**
- **Meet small business goals**

RAND

Finally, in determining whether the SBIR program supports DoD's R&D needs, we attempted to identify specific purposes to which the program is applied. DoD participates in the SBIR program primarily because it is legally obligated to do so. That said, the program is used in other, more focused ways by each of the DoD services and agencies, although how much these other uses are stressed depends on which service or agency is involved. Almost every DoD organization with an organic R&D capability indicated that the SBIR program was used to supplement those organic efforts. Interestingly, one agency SBIR manager noted that the SBIR program was an important source of research funding for programs that would not otherwise be funded because of technical risk. In some cases, the program also appears aimed at supplementing program office acquisition efforts, although this seemed to be a lower priority, except in the Navy. There is also at least one recent example of the DoD SBIR program being used to move R&D money into a high-priority

effort.⁸² Another agency described using the SBIR program to fund fairly quick-reaction R&D efforts to solve near-term operational needs. Finally, the SBIR program is a part of DoD's overall program to meet its congressionally mandated goals for contracting with small businesses.⁸³

⁸² Executive Order 13329 requires the head of each executive branch department or agency with one or more SBIR programs to make manufacturing-related R&D a priority of the SBIR program (President of the United States, 2004).

⁸³ Congress has established a governmentwide statutory goal of 23 percent for small business prime and subcontracting. Each agency, including DoD, work with the SBA to establish realistic goals that contribute to the governmentwide goal (U.S. Small Business Administration, 2005b).

***Broader RAND Findings:
Business Models of Contractors That Use SBIR***

- **Entrepreneurial** – A new business, created to develop a new product. SBIR is a source of capital
- **Mature business** – Continuing research efforts to maintain competitive position. SBIR is low financial risk research funding
- **Non-DoD business** – Small non-DoD business looking for an entrée into the defense sector
- **Research house** – In the business of conducting research. SBIR is a funding source

RAND

By examining the DD350 database for SBIR contracts and looking in more depth at some of the actual SBIR award winners, we identified four distinct business models for DoD SBIR award winners: the research house, the entrepreneurial model, the mature business model, and the non-DoD business model.

The entrepreneurial model is a (relatively) new business created specifically to develop some product or service. The stereotypical example of the entrepreneurial model is the graduate student or college professor who creates a company to commercialize university research and hopes to develop a market for its products. For these kinds of businesses the SBIR program is a source of relatively inexpensive capital for developing their ideas.⁸⁴ SBIR funding can also play an

⁸⁴ Other forms of capital come with a high price. For example, bank loans, when available, must be repaid with interest. Venture or “angel” capital is typically given in exchange for equity in the company. (Angel capital is similar to venture capital but is provided by individuals, or groups of individuals, rather than by a formally established venture firm.) SBIR money requires only the filing of a report at the end of the

important "validation" role for the entrepreneurial model, helping to pave the way for other forms of capital.

In the mature business model the SBIR program also represents a source of low-cost capital for research. Unlike the entrepreneurial model, however, mature businesses are not as likely to fail, may often have experience dealing with DoD, and may have greater internal resources on which to draw. These businesses use SBIR contracts to fund research that appears promising but that is riskier than the company is comfortable funding from internal resources or is not on the critical path to product development. The risk may be technological, competitive, or market based. Mature businesses may also use SBIR contracts to maintain a competitive position in the market, particularly when the market is DoD.

We also identified what appear to be examples of established companies using the SBIR program as a way of entering the DoD market. For these companies, the SBIR program represents a low-risk, low-cost method for establishing contacts and demonstrating ability in the DoD R&D community.

Finally, the research house is a company in business to conduct research as a service or to develop technology that can be licensed or otherwise spun off. This model is one often perceived as the archetype "frequent SBIR award winner" (FAW).⁸⁵ It is to this model that we now turn our attention.

contract and the provision to the government of "government purpose rights" in the intellectual property that results from the research. Even when government purpose rights are ceded, the company retains all rights in terms of the commercial development of the intellectual property and will normally retain the government market for products and services that result from the intellectual property. None of this is to say that SBIR money comes without restraints; it comes relatively slowly, in relatively small amounts, and is available only if the company meets the size criteria and its research capabilities and requirements match the topical areas.

⁸⁵ FAWs are often referred to as "SBIR mills."

***Broader RAND Findings:
There Is Some Concentration of Phase I Awards with
Frequent SBIR Award Winners***

# of Phase I Awards/Company (1993-2002)	Number of Companies	% of Total Phase I	% of Total Phase II (1994-2003)
<= 10	3734	57.5%	58.2%
11 - 20	133	13.5%	13.8%
21 - 30	49	8.6%	8.3%
31 - 50	27	7.3%	6.7%
51 - 100	17	8.4%	8.2%
> 100	4	4.8%	4.7%

- 71% of Phase I awards were won by companies that averaged fewer than two Phase I awards/year
- Phase II awards are no more concentrated than Phase I awards

RAND

Contract data were extracted from DD Form 350,
<http://web1.whs.osd.mil/peidhome/guide/procooper.htm>

Discussions of the SBIR program and examination of the relevant literature invariably raise the question of whether the program is creating FAWs—that is, small companies that win a disproportionate share of the SBIR contracts.⁸⁶ If this is in fact the case, the goal of increasing small business participation in federal R&D could be frustrated. The degree to which this occurs would be in proportion to the percentage of SBIR contracts that are routinely awarded to a small number of companies.

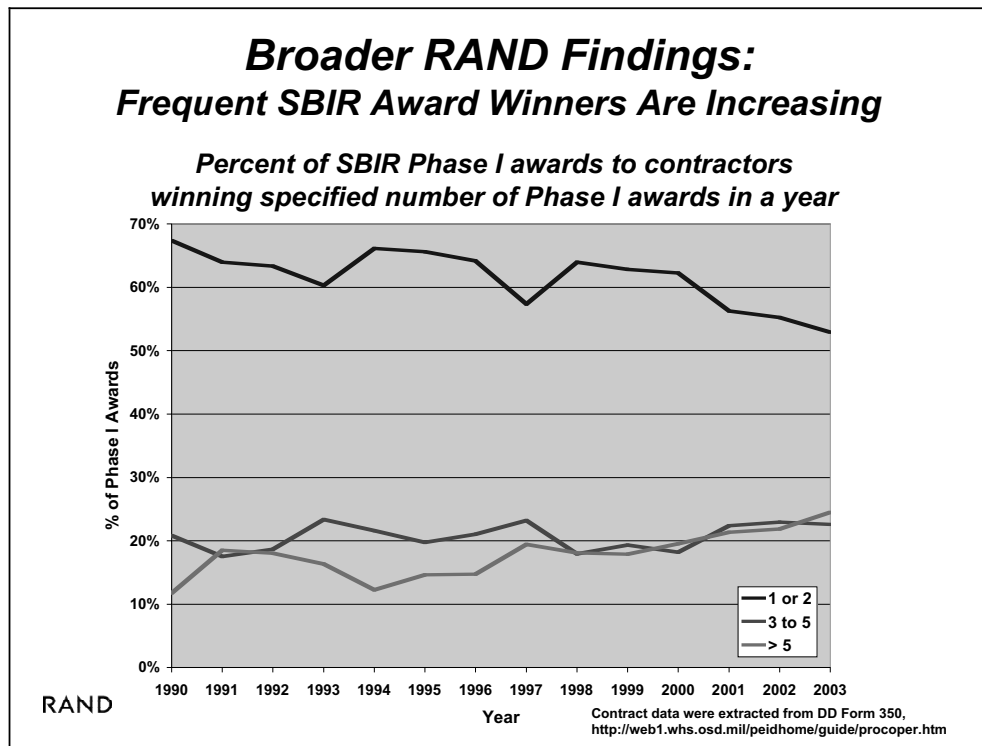
The DD350 database allows a determination as to whether FAWs are a significant part of the DoD SBIR program and whether they are an increasing share of the program. Of the nearly 4,000 contractors participating in the DoD SBIR program between 1993 and 2002,⁸⁷ 21 (one-

⁸⁶ FAWs are also characterized anecdotally, and often pejoratively, as being companies that, over time, have developed a business model that relies on the SBIR program, rather than on research results, for company revenue.

⁸⁷ Typically, Phase II awards are made a year or more after the Phase I award. We therefore used the ten-year period (1993-2002) for our Phase I sample to compare it with the Phase II awards that would follow in the period 1994-2003. Also, each record in the DD350 database

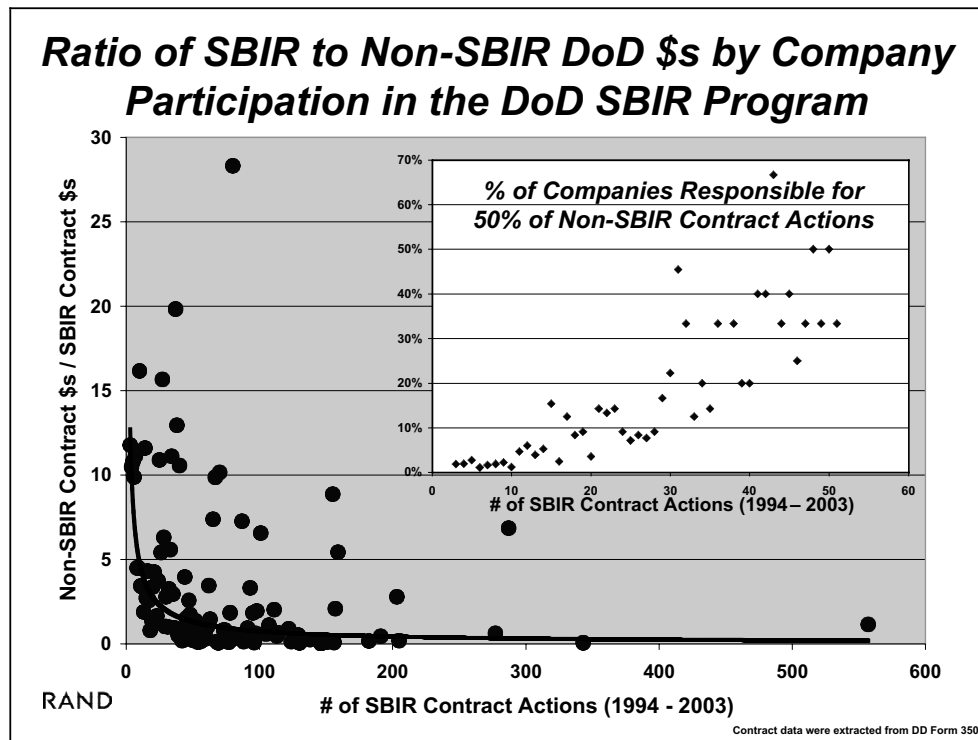
half of 1 percent of all DoD SBIR Phase I contractors in this period) won more than 50 SBIR Phase I contracts, accounting for 13 percent of the total DoD Phase I SBIR contracts. In fact, 29 percent of DoD SBIR Phase I awards went to 97 companies (2.4 percent of all companies) that each won more than 20 SBIR Phase I awards during the 1993-2002 period. While these statistics indicate a concentration of awards with a small number of FAWs, it is important to point out that 71 percent of Phase I awards were won by companies that averaged two or fewer Phase I awards per year. This reiterates that the DoD SBIR program provides an opportunity for a large number of small businesses to contract with the department. It is also significant that Phase II awards were won at a rate, across the range of SBIR companies, that was nearly identical to the rate of Phase I awards to those companies. This indicates that the companies that win only a few Phase I awards are just as likely as FAWs to follow a Phase I award with a Phase II contract.

identifies a "contract action" rather than a unique contract. Most Phase II awards and some Phase I awards have multiple "contract actions" associated with them. For this analysis, we consolidated awards by their unique contract numbers and used the year in which a contract number first appeared as the year of the SBIR award.



Notably, the concentration of Phase I awards with FAWs is increasing. In 1994 12 percent of the DoD SBIR Phase I contracts were awarded to companies that won more than five DoD SBIR Phase I contracts in that same year. In 2003 the percentage of DoD SBIR Phase I contracts awarded to companies winning more than five DoD SBIR Phase I contracts more than doubled to 25 percent. In the same period, the percentage of Phase I awards to companies awarded only one or two DoD SBIR Phase I contracts per year declined from 66 percent to 53 percent.

To a certain extent, FAWs provide a contracting outlet for the growth in funds available to the SBIR program. Funneling a large portion of the SBIR contracts to companies well versed in the mechanics of the program has the effect of reducing the overhead per SBIR contract that is required to manage the DoD SBIR program.



While the participation of FAWs in the DoD SBIR program is growing, the impact of that participation is not clear. One indicator of DoD use of FAWs is whether these companies also engage in more traditional contracting with the department. For the period from 1994 to 2003 we looked at the ratio of non-SBIR DoD contract dollars to DoD SBIR contract dollars for all participants in the DoD SBIR program. The average of this ratio for all companies with the same number of SBIR contract actions over this period is plotted here against the number of SBIR contract actions for that group.⁸⁸ The resulting graph has significant scatter,⁸⁹ but the trend is relatively clear. With notable

⁸⁸ For this plot, companies with only one or two SBIR contracts in the ten-year period were omitted. Random DD350 coding errors occasionally introduce non-SBIR contractors into the database. These contractors may have a large number of standard contracts and would skew the data for companies with very small numbers of SBIR contracts. Omitting companies in the database that show only one or two SBIR contracts greatly reduces this problem. The DD350 database was also manually scrubbed to eliminate these companies from it.

⁸⁹ The power function displayed on the chart ($y = 30.829x^{-0.8072}$) is a best fit to these data, but the R^2 value is only 0.244.

exceptions, on average, the more DoD SBIR contracts a company wins, the lower the ratio of non-SBIR DoD contract dollars to DoD SBIR dollars. This seems to indicate that, in general, companies that win a lot of DoD SBIR contracts have a business model that is more reliant on the SBIR program for revenue than standard contracting. This potential finding is confounded, however, by a fact noted earlier: A very few DoD SBIR companies are responsible for the vast majority of the non-SBIR DoD contracting in which the population of DoD SBIR companies engage. The inset plot shows the percentage of companies responsible for half the non-SBIR DoD awards for groups of DoD SBIR companies categorized by the number of SBIR contract actions in the period from 1994 to 2003.⁹⁰ What this plot shows is that, in general, for companies with very few DoD SBIR awards, a relatively small number of those companies account for the majority of the DoD non-SBIR contracts, as measured by total dollars. A converse way to say this is that most of the non-FAW DoD-SBIR companies are also reliant on the SBIR program for their DoD business. What remains for further study is the extent to which licensing of technology and other means of technology transfer play a role in the business model of SBIR companies.

⁹⁰ There are a number of instances in which there was only one company that had a particular number of contract actions over the course of the decade (e.g., only one company had 68 SBIR contract actions during the ten years of interest). The companies in these cases naturally had 100 percent of all non-SBIR DoD contracts and are not displayed on the chart.

Comparison of DoD Contracting Activity by SBIR Frequent Award Winners

		1994 - 1998				1999 - 2003				Acquired or Merged
Constant 2003 \$s	# of SBIR Companies	Avg. Number of DoD Contract Actions per Company		Avg. DoD Revenue (Millions) per Company		Avg. Number of DoD Contract Actions per Company		Avg. DoD Revenue (Millions) per Company		
		SBIR	Non SBIR	SBIR	Non SBIR	SBIR	Non SBIR	SBIR	Non SBIR	
New	53					55.2	124.9	11.1	34.5	3*
Continuing	58	47.6	59.0	10.7	15.7	59.1	75.6	12.0	22.0	6*
Previous	16	49.2	36.6	11.6	18.3					8**
Total	127	47.9	54.1	10.9	16.2	57.2	99.2	11.6	27.9	17

*Acquisitions and mergers occurred in 2002 and later

**Two other early FAW continue to do business with DoD but have outgrown the SBIR program

- Use of the CAI may mitigate concerns about FAWs
- New (99 – 03) FAWs receive three non-SBIR \$s for every SBIR \$ from the DoD, twice the rate of the earlier measured period (94 – 98)
- Continuing FAWs also improved
- FAW are often acquisition/merger targets. 19% (14 of 74) earlier FAW have been acquired or merged with another company

RAND

Contract data were extracted from DD Form 350

The increasing use of the CAI should mitigate any concentration of companies whose business model is reliant on the SBIR program as a primary source of revenue, particularly if these metrics are further refined and rigorously used as an evaluation criterion. Using the CAI as a proposal evaluation tool will provide incentives for companies competing for multiple SBIR awards to find ways to commercialize the results of their SBIR research efforts while reducing the win rate of FAWs whose primary business is conducting SBIR research.

Whether a result of the introduction of the CAI or not, there is evidence that FAWs are already engaging in more standard contracting with DoD. Over the period from 1994 to 2003 we identified 127 FAWs.⁹¹

⁹¹ FAWs in the period 1994–2003 were defined, somewhat arbitrarily, as those companies with 30 or more DoD SBIR contract actions in any continuous five years over the period of interest. Contract actions are not necessarily individual contracts and may be modifications to existing contracts. New FAWs are those that had few or no SBIR contract actions during the first few years of the period and whose participation in the program grew significantly later in the program. "Continuing FAWs" are those whose pattern of DoD-SBIR participation remained either relatively constant throughout the period or whose participation, while

These were segregated into those that became FAWs in the latter half of the period of interest, those with frequent participation in the DoD SBIR throughout the period, and those that left the DoD SBIR program.

For those FAWs that have been continuous participants in the DoD SBIR program the average number of SBIR contracts action during the latter half of the ten years examined increased 25 percent, and the dollars associated with those contract actions increased 12 percent. Significantly, however, for the same group, the average number of DoD non-SBIR contract actions increased by 28 percent, while the average dollars associated with those contract actions increased by 40 percent. In other words, while this group of FAWs increased their participation in the DoD SBIR program quite a bit, their growth in standard DoD business was even more significant. The result is that during the first five years the ratio of standard contracts to SBIR contracts for this group was 1.47 to 1, while for the second five years the same ratio increased to 1.83 to 1. In addition, the ratio of standard DoD to SBIR contracts for the group of new FAWs is even greater at more than 3 to 1.

It is also important to point out that FAWs are relatively frequent acquisition and merger targets. Over the period examined, 17 of the 127 companies have either been acquired by or merged with another company. This includes nearly one-fifth (14 of 74) of the companies identified as FAWs at the beginning of the period. This is an indication that these companies have value. Given the significance of the SBIR program to these companies, much of their inherent value can be attributed to that program.⁹²

varied over the period, was about as strong at the end of the period as at the beginning. Defining a clear distinction between "new" and "continuing" FAWs was not entirely possible because of the varied pattern of DoD-SBIR use among these companies, although potential overlap in categorizing this way involves only a small percentage of companies. Finally, previous FAWs are those companies whose participation in the DoD SBIR program appeared to have ceased at the end of the period. The list of FAWs for 1994 through 2003 is provided in Appendix C.

⁹² In addition to the acquisitions and mergers, two other companies that are no longer in the program have left because they outgrew it and are succeeding without it.

Broader RAND Findings: SBIR Program Overhead Allocation Is Low

- **Managing the SBIR program may require more resources than other DoD contracting programs**
 - Small R&D contracts
 - Many with start-up companies
 - Many doing business with DoD for the first time
- **Most of the DoD SBIR program management appears underresourced by comparison with other programs**

<i>Non-Navy DoD SBIR</i>	<i>Navy SBIR</i>	<i>DoD Contracting</i>	<i>Government VC</i>	<i>Commercial VC</i>
~ 2 %	6 %	2.7 %	4 - 5 % + ROI	2.5 % + ROI

Sources: DoD SBIR – Based on a labor hour estimate disclosed during an interview with a DoD Component SBIR Program Manager
 Navy SBIR – Based on an interview with Mr. John Williams, Office of Naval Research
 DoD Contracting – Based on GAO estimates of acquisition workforce labor years of effort
 Government VC – Based on management fees associated with OnPoint, the US Army's venture capital initiative, and CDC, a British government venture fund
 Commercial VC – Based on "Venture Planning Associates, Venture Capital Firms" http://www.1000ventures.com/venture_financing/vc_firms_byvpa.htm

RAND

Managing the DoD SBIR program may require more resources than other DoD contracting programs require. By its nature, R&D is difficult to measure and assess, requiring some level of oversight to manage the course of the research to improve the likelihood that useful outcomes will result. This difficulty is only exacerbated when the resources are dispersed as in the DoD SBIR program, which awards thousands of small R&D contracts annually.⁹³ Complicating the nature of these R&D contracts is the fact that many of the SBIR awardees are very young companies with little experience or infrastructure available for their own internal management. Additionally, many SBIR awardees, as we noted earlier, are new to the DoD market. The implication is that young companies doing business with DoD for the first time may require more oversight and "hand-holding" than an experienced contractor would. Considering these issues and the sheer number of SBIR contracts, the need for significant DoD management and oversight seems obvious.

Instead, we found that the SBIR program is run in a very lean manner. Most day-to-day management of the DoD SBIR program occurs at the

⁹³ In 2003 the DoD SBIR program awarded more than 3,000 Phase I contracts and more than 2,000 Phase II contracts.

major command, laboratory, and program office levels, although the level of effort accorded to managing each contract appears to vary widely across the department. Anecdotally, however, we determined that there is a tendency is to manage each contract with a minimum amount of effort.⁹⁴ At the military department and DoD agency level, just a few people manage their respective programs. For the military departments, management usually involves only one or two government personnel and several contractors. For the DoD agencies, SBIR management depends on the size of the program. There may be a government person and a few contractor personnel or just one part-time person assigned to managing the program. With so few people, the focus of SBIR program managers is necessarily on compliance in terms of spending the required percentage of DoD's extramural R&D budget rather than on R&D outcome. SBIR managers claim that the pace is quite relentless, since, depending on the service or agency, each annual cycle requires oversight of tens or hundreds of million dollars in small contracts.

We were unable to find any prior research on the proper level of overhead to allocate for the management of R&D contracts. Consequently, we searched for comparable measures of contract management overhead. We roughly estimate that the SBIR program invests only about 2 percent of the SBIR contract value into managing the program.⁹⁵ The Navy is the

⁹⁴ During the course of this study, we did not collect data systematically concerning management at the SBIR-contract level. As a result, we are relying on our impressions from conversations with a relatively small number of people in DoD who have had experience with the SBIR program at the contract level and with people who have competed for and received DoD SBIR contracts.

⁹⁵ One DoD component SBIR manager estimated the labor hours expended across the component to manage its SBIR program (interview with the component SBIR Program Manager during the 2004 National SBIR/STTR Conference and Small Business Tech Expo [SBTE], Atlanta, Georgia, April 26-28, 2004). We used this figure to estimate the overhead allocation to the component's SBIR program and assumed that other DoD SBIR programs, with the exception of the Navy, are managed in a similar manner (U.S. Department of Defense, 2005a). The Office of Personnel Management publishes a cost per work year for the civilian employees of the federal government. The last year of published data was for FY 2001 (U.S. Office of Personnel Management, 2003). We used the FY 2001 figure for average cost of a DoD employee and used the DoD civilian pay deflator to arrive at an average cost per labor-year of \$64,946 (U.S. Department of Defense, 2002b).

exception, investing roughly 6 percent of the program value into program management, technology transfer efforts, and company assistance.⁹⁶ By comparison, the federal government allocates at least 2.7 percent of total contract value to managing its contracts.⁹⁷ Venture capital companies provide another point of comparison because they typically invest in young, technologically oriented companies that are trying to break into or create new markets. We divide venture capital companies into two types for this comparison: government-owned or -backed funds and private equity funds. Government-owned funds tend to have a number of specific government purposes, ranging from economic development to technology development. As a result, their 4-5 percent overhead expenditures⁹⁸ tend to be greater than the 2.5 percent management fees that private equity funds charge.⁹⁹ However, private equity funds are established to make money, and the fund managers earn a return on their investments in addition to the management fee.

⁹⁶ These resources are in addition to the 2.5 percent of extramural R&D that fund the Navy's SBIR contracts (John Williams and Allen Baker, Office of Naval Research, interview with authors, January 19, 2005).

⁹⁷ The GAO calculated that in FY 2001, the federal procurement and acquisition workforce was employed in 68,513 labor-years of effort. This effort managed \$152.6 billion in contracts and other acquisition activities. Since we did not know the average cost per labor-year of the procurement and acquisition workforce, we substituted the average annual cost per labor-year of the federal workforce: \$60,571 (U.S. Office of Personnel Management, 2003).

⁹⁸ Two examples of government funds are the CDC Group, owned by the British government, and OnPoint, a fund created by the U.S. Army. The CDC Group invests in developing countries to make an economic impact. In 2003, its staff costs of £45.8 million on £888.6 million in equity investments, loans, and cash imply an overhead rate of 5.2 percent (CDC Group, 2003). OnPoint is a not-for-profit venture capital fund run for the Army by Military Commercial Technologies to invest in power and energy technologies for the soldier. The "other transaction" agreement between the Army and OnPoint allows a 4 percent management fee (Nancy Norton, contracting specialist, U.S. Army Communications Electronics Command, telephone communication with lead author, January 6, 2005).

⁹⁹ Venture Planning Associates (2005) provided the 2.5 percent figure. This figure was confirmed in other discussions with people in the venture capital industry.

IMPROVING THE DOD SBIR PROGRAM

Outline

- DoD SBIR program and history
- DoD SBIR goals and metrics
 - DoD's evaluation of current goals
 - RAND's evaluation of current goals
- Other RAND findings
- **Improving the DoD SBIR program**
- **Conclusions**

RAND

Up to this point, our discussion has focused on the current state of the DoD SBIR program. We now turn to recommendations aimed at improving the DoD SBIR program's relevance to DoD's national security mission. We divide these recommendations into two overlapping, but distinct, sets. First, we present three broad prescripts for establishing the DoD SBIR program as a key resource in the department's overall RDT&E program. Second, we introduce several policy options for using the DoD SBIR program in ways that could better contribute to the Under Secretary of Defense for Acquisition, Technology and Logistics' (USD[ATL]'s) goals for the defense acquisition community.

Policy Question

Can the DoD SBIR program be more effectively used by DoD to further its broad national security mission?

RAND

As noted earlier, the DoD SBIR program appears to be meeting the broad goals set out for it in the enabling legislation. Those broad goals, however, had little to do with the national security mission of DoD. This situation raises the question of whether the DoD SBIR program can be more effectively used by DoD to further its broad national security goals.

There Are Three Fundamental Steps for Improving the DoD SBIR Program

The goal should be maximizing the value of the program to the department, not minimizing the SBIR budget

- 1. View the DoD SBIR program as a potential resource, not just a tax**
 - ~\$1 Billion/Year (This is real money)
 - Within the constraints of the program, SBIR is very flexible
- 2. Identify DoD-specific goals for the SBIR program and measure progress against those goals**
- 3. Resource the program to manage outcome effectiveness**
 - Government venture capital and Navy SBIR are suggestive of what may be required
 - Identify and train the right managers

RAND

At present, R&D managers often view the SBIR program primarily as a tax on their R&D programs. In addition, both the effort required to effectively manage many small R&D contracts and the lack of overhead to pay for that effort reinforce the perception that the SBIR program is just another mandate to put up with. For the DoD SBIR program to be improved, the R&D and acquisition communities must appreciate more that the SBIR program is an investment that could generate a significant return if used effectively.

This concept is important if for no other reason than the DoD SBIR program, at about \$1 billion each year, is “real money”—an amount significant enough to warrant high-level leadership attention. Moreover, the funding is very flexible. The act creating SBIRs puts few constraints on what kind of R&D can be addressed with SBIR funds, which means that grantees can use the funds to address goals that cannot otherwise be addressed using more highly constrained funds.

Without measurable, DoD-specific goals, however, it is unlikely that the DoD SBIR program will ever achieve its potential value to DoD. Such goals are needed to provide a focus around which an effective

investment strategy may be formed and to provide a benchmark for evaluating how well the program is serving the department.

As noted earlier, the DoD SBIR program appears to be managed in a very lean manner. We also note our inability to find compelling evidence that the program currently provides significant return value to DoD. Together, these suggest that additional resources may be required before DoD will be able to more effectively use its SBIR program. While certainly not dispositive, comparable programs and enterprises, like government venture capital funds, are managed with substantially greater resources than the DoD SBIR program has and could provide some indication of what is needed.

All three of the steps outlined here require DoD's R&D and acquisition leadership to think in terms of potential SBIR program value rather than just near-term budget impacts. While resources for the SBIR program will initially need to come from some near-term accounts, these will be justified if substantially greater R&D value can be extracted from the SBIR program.

Recommended SBIR Goals That Link to Several of DoD's Broader Acquisition Goals

- **Technology dominance**
 1. Improve invention-to-use time for military technologies
 2. Provide technology intelligence about current commercial technology developments and trends
 3. Generate innovative solutions to DoD requirements
- **Improving the industrial base**
 1. Broaden DoD's technological base and increase competition by building and strengthening innovative companies willing to do defense work
 2. Improve ties between prime contractors and the small, technology-oriented business community
 3. Expand intellectual and innovative capital in the U.S.

RAND

Michael Wynne, the acting USD(ATL),¹⁰⁰ "established *Seven Goals for AT&L* specifically targeted to drive performance outcomes that will directly contribute to our joint warfighting strategy and to transforming DoD's business processes."¹⁰¹ The SBIR program can clearly be part of the strategy for achieving at least two of these seven goals: technology dominance and strengthening the industrial base. Our suggestions for DoD SBIR program goals are therefore derived as measures that will help further these broader goals.

We suggest three DoD SBIR program-specific goals as prospective contributions to maintaining the U.S. military's technology dominance. First, DoD SBIR contracts should be used to help shorten the time from idea to invention to warfighter capability, enabling DoD to move new technology to the field more quickly than its adversaries will. Second,

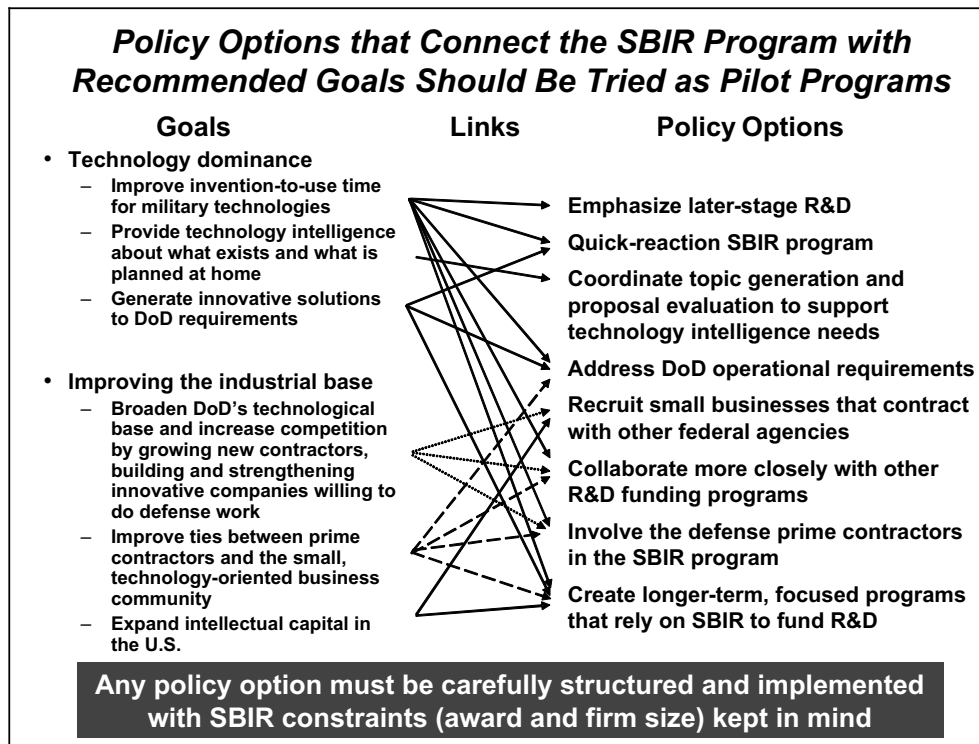
¹⁰⁰ Kenneth Krieg has since replaced Michael Wynne as USD(ATL).

¹⁰¹ The seven goals are (1) acquisition excellence with integrity, (2) logistics integrated and efficient, (3) systems integration and engineering for mission success, (4) technology dominance, (5) resources rationalized, (6) industrial base strengthened, and (7) motivated, agile workforce (Wynne, 2004).

DoD needs better knowledge about what technology exists, what is being developed, and what is being forecast. The high-technology commercial sector of the U.S. economy is very large, quite diverse, and often somewhat removed from the defense technology and industrial base. As a result, it can prove problematic for DoD's technology managers to maintain knowledge of research activities, trends, and specific developments that occur outside the defense technology and industrial base. Targeted SBIR solicitations can help provide insight into domestic technology trends that might otherwise be overlooked. Third, the small business community can be a tremendous source of innovation, providing a unique perspective on the DoD's needs. The SBIR program can be an effective tool for tapping that source.

In his testimony to Congress, Mr. Wynne explained that the goal of improving the industrial base means developing and implementing "policies that encourage smart industrial base management on the part of acquisition program managers to keep the industrial base robust and responsive." Such policies include "identify[ing the] critical industrial capabilities smaller innovative firms can provide."¹⁰² The acknowledgement that small, innovative firms can play an important role in improving the defense industrial base suggests a role for the DoD SBIR program and several goals. First, it should be aimed at helping to expand the stable of private-sector companies that are capable of and willing to provide DoD with the technology it needs. Second, the DoD SBIR program should be tailored to improve the links and collaboration efforts between the large defense prime contractors and the small, technology-oriented business community. Third, DoD's leadership should aspire to use its SBIR program to more generally expand the intellectual and innovative capital in the United States.

¹⁰² Wynne (2004).



The study team developed a set of policy options that map to the suggested DoD SBIR goals that we described in the previous slide. Several of the options are based on programs and policies similar to ones already in place.¹⁰³ Some derive from our understanding of congressional and departmental intent for the SBIR program.¹⁰⁴ Finally, others were developed with our recommended DoD SBIR goals directly in mind.

Over the remainder of this briefing, we examine the various policy options in somewhat greater detail. In all cases, however, we recognize that the details of each policy option need to be explored in much greater depth than is provided here. Additionally, most of these options

¹⁰³ These include (1) The quick-reaction SBIR program that is suggestive of programs in DoD meant to respond rapidly to immediate operational needs, (2) the option to use the DoD SBIR program to address DoD operational requirements, which reflects acquisition policy that materiel requirements statements address operational needs rather than suggest technical solutions, and (3) the idea that SBIR projects should be coordinated with other R&D programs, which reminds us of current R&D and acquisition efforts to manage product life cycles.

¹⁰⁴ These include placing more emphasis on later-stage R&D and recruiting small businesses from other federal contracting programs.

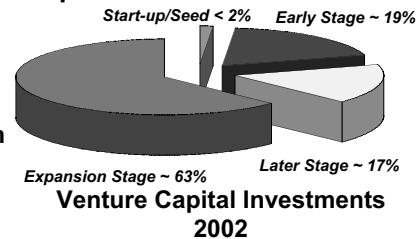
represent a relatively significant departure from current practice in the DoD SBIR program. As a result, we recommend that adoption of any of these policies be preceded by a limited trial of the policy through a pilot program. Pilot programs will help to establish the worth of the policy while simultaneously suggesting improvements for implementation on a larger scale.

This is also the appropriate time to point out that, while being quite flexible, the SBIR program does have constraints that must be kept in mind. The two most important of these are that the firms involved are small businesses and so may be limited in their capabilities. Perhaps more significant is the limitation on award size. Combined Phase I and Phase II awards will generally not be greater than \$850,000, although occasionally this limit may be exceeded by exception. SBIR projects must therefore accommodate projects that can be accomplished with this relatively small amount of money. The practical effect is that individual SBIR projects generally need to have limited objectives. For example, rather than using SBIR awards for system development, SBIR projects might aim to solve specific component problems. Alternatively, bundling SBIR projects to solve larger problems may be possible, and some potential ways to do that are outlined in the policy options that follow.

Policy Option: Emphasize Later-Stage Research & Development

- SBIR is more appropriate for later stages of technology (primarily 6.3, 6.4, and 6.7 level) development because:

- Emphasis is on “invention-to-use” time and commercialization
- Small entrepreneurial businesses may lack the capital and longer-term commitment required to commercialize basic and applied research



- The DoD SBIR program should emphasize topics generated by program offices; depots; experimental commands; battlelabs
 - Identify technologies that can be put into the hands of warfighters more quickly
- Rigorous application of commercialization metrics should prompt a larger percentage of later stage proposals

RAND

Source: National Venture Capital Association

A primary purpose of the SBIR program is commercializing federally funded R&D, and we recommended a related but more DoD-specific goal: to improve “invention to warfighter-use time.” Given this goal, it is inappropriate to invest a majority of the department’s SBIR funding in early-stage research. This timing disconnect is especially important when considering that small businesses are often not well structured to commercialize basic and applied research results. The tasks involved are often capital intensive, require long-term commitments, and generate little of the cash flow needed by small businesses to stay solvent. Additionally, the amount of time required and the risk inherent in translating basic and applied research into marketable products makes securing follow-on funding to SBIR contracts an onerous task.¹⁰⁵ These

¹⁰⁵ The funding gap that develops between proving an idea is feasible and having producible prototypes is so well known and onerous that it has earned the name “The Valley of Death.” For example, see Kalil (2005).

challenges help explain why venture capitalists tend to invest in later stages of company, product, and market development.¹⁰⁶

SBIR investments should, therefore, be made in later-stage R&D, primarily 6.3 (advanced technology development), 6.4 (advanced component development), and 6.7 (operational system development).¹⁰⁷ The objective of investing SBIR funds in later-stage development is to put more DoD SBIR dollars where they may be more effective, namely in areas where there are more likely to be application-ready technologies. This is not to say that there should be no DoD SBIR investments in basic or applied research but rather that a much larger percentage of DoD's SBIR money should go toward more developed technologies. This shift is best accomplished by utilizing offices and organizations involved in later-stage product and technology development more often in the topic generation process, as well as developing the DoD SBIR program (in ways to be discussed) to be a resource for, rather than a burden to, these participants.

As noted earlier, more rigorous application of commercialization metrics like the CAI should help push the SBIR program toward later-stage R&D. When companies returning for additional SBIR awards are penalized in the selection process because their earlier SBIR projects were too early in the R&D process for easy commercialization, they will be incentivized to adjust their proposals to later-stage R&D. This effect should apply especially to FAWs that rely to a greater degree on the SBIR program.

¹⁰⁶ 80 percent of venture capital investments were for late and expansion stage companies. (National Venture Capital Association, PricewaterhouseCoopers, and Venture Economics/Thomson Financial, 2003)

¹⁰⁷ 6.5-level work--system development and demonstration--may not be as appropriate for Phases I and II of the SBIR program. During this stage of R&D, the extensive engineering, finishing, and testing of products and systems require funding levels that are more appropriate for a Phase III program.

***Policy Option:
Establish a Quick-Reaction SBIR Program***

- Reprogramming committed funds to meet immediate operational requirements can be bureaucratic and involves difficult decisions
- SBIR money is “unprogrammed,” very flexible, and more available, therefore attractive for addressing immediate problems
- Many current program restraints are artificial and could be removed. A quick reaction program would need:
 - More frequently scheduled solicitations
 - Compressed timing of phase awards
 - Flexible/innovative funding
 - Additional management resources
- Existing organizations like the Agile Development Center in the U.S. Army’s Research Development Engineering Command are potential vehicles for managing a quick-reaction SBIR program

RAND

When DoD is faced with a quick-reaction R&D requirement,¹⁰⁸ the process to reprogram money already allocated in the budget involves difficult and often time-consuming decisions concerning which programs should provide the resources. The DoD SBIR program, however, is very flexible because SBIR funds are unprogrammed. There are no “basic research,” “applied research,” or other kinds of research restrictions to SBIR funds. As noted earlier, past SBIR topics have tended toward basic and applied research, but that is due more to how topics are generated than to some mandate that SBIR funding be spent on different levels of research or in prescribed proportions. This flexibility

¹⁰⁸ We define quick-reaction R&D requirements as operational deficiencies that are typically the result of a materiel shortcoming, a change in situation, or unanticipated enemy actions. They are normally identified during the conduct of military operations or are anticipated during preparations for future operations. A quick-reaction R&D requirement envisions materiel or process development or improvement as a solution to the immediate need. DoD’s Quick Reaction Special Projects defines quick reaction as maturing technology in less than a year (U.S. Department of Defense, 2004g).

suggests that the DoD SBIR program could be an effective tool for responding to some quick-reaction R&D requirements.

One limitation of the current SBIR program is that it is very schedule driven. The SBID Act requires that the SBA and agencies participating in the SBIR program develop and publish a schedule of solicitations each year to maximize the opportunities for small businesses to respond.¹⁰⁹ DoD published four solicitations in 2004, although until last year it had published only two solicitations per year and will publish only three in FY 2005. The solicitation schedule requirement necessarily drives the topic generation process as well as contract award. This schedule greatly simplifies the "process" aspects of the SBIR program, making it simpler and less labor intensive to administer. Administrative efficiency, however, is achieved at the "cost" of imposing constraints and limiting the flexibility of the SBIR program. SBIR phasing is managed a bit more flexibly, but even there, additional flexibility may be possible.

Given additional skilled management resources, the SBIR program could be made more flexible from a scheduling point of view. Meeting the current requirement "to develop a schedule of solicitation publication each year and to publish that schedule" while enhancing flexibility requires more frequent solicitations than is now the norm for the DoD SBIR program. Ideally, the DoD SBIR program should publish some or all of its solicitations on an ad hoc basis, although this would require an amendment to the SBID Act. Absent new legislation the SBA and DoD could agree to a special, very frequent award schedule to meet the needs of a quick-reaction SBIR program. This schedule would most likely need to be distinct from the primary solicitation schedule and clearly identified as addressing quick-reaction SBIRs. A schedule that allows new solicitations every two to three weeks should be adequate to meet the needs of a quick-reaction SBIR program. Additionally, the administrative structure for managing SBIR solicitations in DoD would need to be adapted to manage the quick-reaction program, particularly in how topics are developed and reviewed. Topic development and review, solicitation composition and posting, and award selection would need to occur in a

¹⁰⁹ 15 USC 638(b)(5); 15 USC 638(g)(2).

matter of days or weeks, as opposed to the months that it now takes. This change will be possible only with additional management resources and possibly the delegation of topic approval authority to the services and agencies.

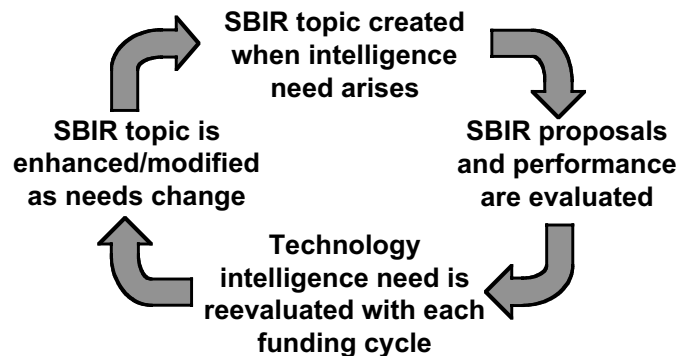
Fortunately, the timing of phase awards is already inherently flexible. The basic requirement merely states that Phase I will generally not last longer than six months; Phase II will generally not last longer than two years. This means that a Phase II award could be made as quickly as the Phase I work could be accomplished and the Phase II award process completed.

There are already organizations and funds in place in DoD with quick-reaction R&D missions. The Army, for example, has an Agile Development Center within its Research, Development and Engineering Command whose primary mission is quick-reaction response to operational needs.¹¹⁰ Such organizations could be trained to use the SBIR program as a source of innovation when quick-reaction R&D requirements arise.

¹¹⁰ See U.S. Army Material Command (2003), p. 9. Another example is the DoD-level Quick Reaction Special Project (U.S. Department of Defense, 2004g).

***Policy Option:
Coordinate Topic Generation and Proposal Evaluation to
Support Technology Intelligence Needs***

Coordinate with agencies that assess technology intelligence



RAND

Topic generation and proposal evaluation within the SBIR program could be better coordinated to enhance technology intelligence.¹¹¹ We propose a four-stage process that continually seeks areas ripe for generating products and services addressing DoD's operational needs. In the first stage, a topic is created when a technology intelligence need arises. Here, DoD targets a particular technology about which more information and expertise is desired by writing SBIR topics specific to that need. In the second stage, companies that can address the topic respond to the SBIR solicitation with specific proposals. These proposals are evaluated and SBIR contracts awarded according to the capabilities of each company to address the specific technology intelligence need. In the third stage, which occurs at the beginning of a funding cycle, the intelligence need is reevaluated to determine not only whether it still exists but also whether there are sufficient

¹¹¹ Technology intelligence is the gathering and assessing of information about technology development that could escape notice by DoD.

ongoing efforts being funded to address it. In the final stage, the topic description is modified or enhanced to reflect the degree to which the need has changed.

These stages are in fact cyclical. Topic enhancement or modification is viewed in the same way as topic generation, and each topic is evaluated to ensure that it addresses a particular intelligence need. In this way, the SBIR grants can be tied to and coordinated with agencies that assess technology intelligence.

***Policy Option:
Frame Some Topics to Address Operational Rather Than
Technical Requirements***

- **State SBIR topic objectives in operational terms**
 - E.g., “mitigate the effect of improvised explosive device problem on security operations in urban environments”
 - Expands the options for addressing operational problems in innovative ways
- **Increases the difficulty of proposal evaluation and comparison**
 - Varying technical solutions may require varying evaluation expertise
 - Topic manager will need resources to conduct and coordinate evaluation and award selection

RAND

As noted earlier, topic generation for the DoD SBIR program occurs almost exclusively within the department’s laboratories, R&D centers, and acquisition program offices. As a result, the vast majority of DoD SBIR topics are directly relevant to specific technologies or address specific technology problems.¹¹² Very few topics address more-general

¹¹² To give an example, we randomly selected 20 of the Army’s 258 topics in the 2004.3 solicitation and listed them below. While some of the topics are fairly broad, most are stated in a way that addresses technical, as opposed to operational, problems. (Appendix E contains the full list of topics from the 2004.3 solicitation.)

A04-005 Adaptive Bandwidth High Power RF Antenna
A04-014 Innovative Modular Interlocking Pallet Containers
A04-023 Microsystems Technology (MST) for Fuzing in Low-Spin/Low-G Launch Environment
A04-024 Self-Aiming Laser Acoustic Target Designator/Classifier
A04-025 Embedded Smart Sensor Electronics for Remote Sensing
A04-026 Confined Space Blast Wave Measurement
A04-055 Command Decision Modeling in Distributed Combat Simulation
A04-070 Innovative Standoff Sensor Technology for Military Robotics Platforms

operational requirements. This situation is unfortunate because the small business community has a reputation for being very adept at finding innovative uses for available technology and also at envisioning and developing new technologies to address real or potential markets. Tailoring some topics to address operational requirements, without specifying a technical approach, could allow the small business community to suggest unique approaches to solving the operational requirement, thereby expanding the pool of researchers thinking about innovative ways to solve operational problems.

For example, DoD SBIR Solicitation 2004.3, published May 3, 2004, has two topics that address the problem of the improvised explosive devices (IEDs) that American soldiers were confronted with in Operation Iraqi Freedom.¹¹³ Both topic A04-060, "Vehicle-Based Detection and Neutralization Methods-Devices for Roadside Bombs and Hard Wired Munitions,"¹¹⁴ and topic A04-234, "Standoff Improvised Explosive Device

A04-098 Power The Force: Future Force Power Systems-Critical Enabler for Army Transformation

A04-104 Co-Channel Interference Mitigation Test Apparatus

A04-106 Integrated Wideband Signal Intelligence (SIGINT) Sensor

A04-151 GeoText

A04-192 Novel Protein Nanodelivery Systems for Biological Agent Countermeasures

A04-206 Detection of Protease Activity for the Identification of Biological Toxins and Exposure to Chemical Warfare Agents

A04-210 Solar Refrigeration

A04-220 Passive, Active Stokes Polarization Imaging System

A04-238 Visualization Tool for Animating Combined Multibody Dynamics and Computational Fluid Dynamics Simulations

A04-248 Cooling Objectives and Operative Leverage (COOL) Techniques

¹¹³ This example also demonstrates how a quick reaction SBIR program could improve responsiveness. Army participation in FY 2004 SBIR solicitations was limited to the 2004.3 issue. As a result, although the Army had been dealing with IEDs since the spring of 2003 in Iraq, it took a year to publish SBIR topics addressing the problem.

GlobalSecurity.org (2004) reports that by the end of 2003, 40 to 60 percent of attacks on coalition forces were begun with IEDs.

¹¹⁴ "OBJECTIVE: To develop vehicle-based techniques and devices that can detect and neutralize: 1) roadside explosive charges that are initiated remotely or through hard-wire, and 2) large caliber munitions (100 to 155-mm) that are detonated remotely or through hard-wire. Those detection devices are to be vehicle-based and integratable [sic] into/onto Army vehicles. In addition, they should strive to be highly discriminate, reliable, and avoid giving false alarms" (U.S. Department of Defense, 2004e).

(IED) Detection System,"¹¹⁵ suggest relatively specific solutions to the problem. Although these two topics are probably very appropriate for the SBIR program, there may be ways to define topics so that they address the underlying operational requirement more generally, generating a broad range of responsive proposals. For example, a topic could have as its objective a request for proposals for technical solutions to the IED problem during security operations. By not implying a particular technical solution, responders will be freer to address many aspects of the problem. Indeed, responders might provide suggestions beyond mere detection, instead focusing on emplacement prevention, interference with the IED operators, passive avoidance, or any number of other solutions or mitigation strategies.

The major difficulty in using topics that are written in operational, rather than technical, terms comes with the evaluation and contract award. Proposals in response to technical topics are more easily forwarded to the correct expert and are more readily comparable to competing proposals. Responses to operational topics may vary widely, making selection of the right technical reviewers more difficult and comparison among competing proposals more challenging. Both the technical evaluation and the comparison of competing proposals would require additional management effort, but done correctly they could lead to innovative solutions to otherwise vexing operational problems.

¹¹⁵ "OBJECTIVE: Demonstrate the feasibility of detecting Improvised Explosive Devices (IED) hidden under rocks, concrete, and foliage, at a standoff distance while moving, through the sensor fusion of an impulse ultra-wide band radar with a polarized, 3-dimensional, multi-spectral IR imager" (U.S. Department of Defense, 2004e).

***Policy Option:
Reach Out to Small Businesses That Successfully Conduct
R&D for Other Federal Agencies***

- **Some small, innovative businesses may not consider working with DoD for a variety of reasons**
- **The DoD SBIR program provides a low-barrier entrée to the DoD market**
- **Actively look for small companies likely to succeed in the DoD market**
 - **Other SBIR programs**
 - **Set-aside programs in other federal agencies**
 - **Small technology companies doing business with other federal customers**

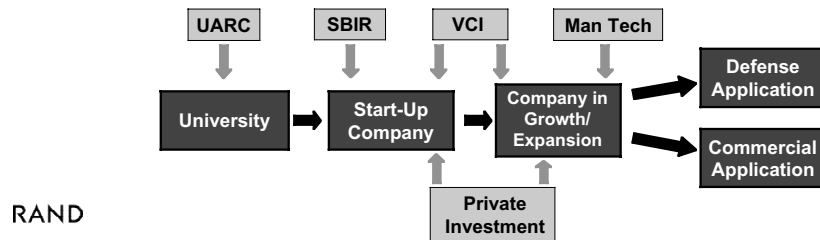
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The objective of this option is to encourage other successful small companies that have won SBIR or other contracts from non-DoD federal agencies to consider contracting with DoD. These companies may be hesitant to enter the DoD market for a variety of reasons: concern about or ignorance of regulations and paperwork, unwillingness or inability to invest in the required market research, or simply a lack of awareness of the military's requirements and how their products may meet them. For these companies, the SBIR program provides a low-barrier entrée into the DoD market, as well as experience dealing with the department.

Successful implementation of this policy option requires that DoD take an active role in identifying and encouraging small businesses that are already contracting with other federal agencies, but not with the DoD, to respond to DoD SBIR solicitations. Small firms doing business with other federal customers can be identified through contacts with the laboratories and R&D centers of non-DoD agencies, as well as the small business offices of those agencies.

***Policy Option:
Collaborate More Closely with Other DoD R&D Programs***

- **SBIR program integration and collaboration across various programs could provide a critical mass of funding to small businesses , at the right time, for technology and business development**
 - **Potential partners include OnPoint, In-Q-Tel, ManTech, battlelabs, Mentor-Protégé program**
 - **Topic generation and proposal evaluation are obvious areas where integration and collaboration are possible**
 - **Requires active management throughout product/technology development**



A number of programs across DoD provide funding for R&D projects outside the standard laboratory or acquisition framework. Examples include venture capital programs,¹¹⁶ rapid fielding initiatives, battlelabs,¹¹⁷ more focused efforts such as the DoD Manufacturing Technology Program (ManTech),¹¹⁸ and other small business initiatives.¹¹⁹

¹¹⁶ OnPoint (mentioned earlier) and In-Q-Tel (the Central Intelligence Agency venture catalyst fund) (In-Q-Tel, 2005) are examples.

¹¹⁷ As one example, the Air Force created seven battlelabs in 1997 with mission to "rapidly identify and prove the worth of innovative ideas" for the warfighter. Links to the Air Force battlelabs can be found in U.S. Air Force (2005). The other services also use battlelabs or very similar organizations.

¹¹⁸ ManTech provides funding for technology invention and development with industrial applications (10 USC 2521). For more information, see U.S. Department of Defense (2005b).

¹¹⁹ For example, the Mentor-Protégé program, established by Public Law 101-510, provides incentives for DoD prime contractors ("mentors") to help small disadvantaged businesses ("protégés") develop technical and business capabilities. For more information, see U.S. Department of Defense, 2005c.

This list is not meant to be definitive, and other appropriate programs should also be identified as candidates for collaboration with the SBIR program.

Collaborative integration of these programs during R&D topic selection and proposal evaluation and an identified and steady funding stream for the entire R&D cycle together could provide improved conditions for commercialization and technology transfer to DoD, thus helping to meet a SBIR program goal while making it easier to speed technology to the warfighter. In addition, creating the conditions for improved commercialization increases the potential for attracting other private investors. The potential for significant funding that an integrated program implies and the active management required to make that integration happen is also more likely to find higher-level attention in DoD than would the individual program components.

An example of how this policy option could work is useful. For this example, we conjecture integrating the activities of one or more university-affiliated research centers (UARCs), the SBIR program, a DoD venture capital initiative, and ManTech. Each of these programs is either already intended to fund a specific research stage that is different from the others identified here or have the flexibility to fund research not addressed by the other programs.¹²⁰ As a result, it is not difficult to envision an integrated program that synchronizes the funding provided by these four DoD programs. The program would begin with basic and applied research at a UARC that develops and validates a technology or technical approach. As this initial work is completed, a company, perhaps a new start-up, would begin exploiting the potential of the invention(s) emerging from the UARC. At this point, one or more SBIR projects would fund the advanced technology development that is needed to turn the technology into a product prototype for testing and market assessment. After the feasibility and potential of the new product are demonstrated through the DoD SBIR program, private and DoD venture

¹²⁰ DoD sponsors UARCs to conduct basic and applied research in a specific technical area. As discussed at length already, the SBIR program sponsors research across numerous R&D stages. Venture capital also funds research throughout the R&D cycle, although it tends toward later-stage product and market development. Finally, ManTech funds R&D of manufacturing and industrial processes.

capitalists fund the continued product, company, and market development. If needed, ManTech funding can also be applied to improve the manufacturing processes that will produce any new product. Eventually, and if managed successfully, marketable products for either or both the military and commercial markets emerge.

Synchronizing the funding programs that make up this policy option will require a DoD manager. A management team drawn from the funding programs involved in this policy option is one possibility. For example, in addition to its existing investment responsibility, the DoD venture capitalist could be given some oversight authority over one of the department's UARCs, the right to select and manage one or more SBIR topics, and access to ManTech funding. The DoD's venture capitalist would presumably be incentivized to use the funding from the various programs in a way that maximizes the probability that some profitable and useful military product is developed. A more straightforward management method would be to create a program office with the responsibility of developing technical solutions to specific operational requirements; the program office would be resourced by the R&D funding programs identified in this policy option. Creation of such a program office is similar to the policy option described next.

***Policy Option:
Create Longer-Term, Project Focused Programs That
Rely on SBIR as a Funding Source***

- **Develop longer-term projects that have defined requirements and schedules**
 - Advanced Technology Demonstrator
 - Small acquisition project
- **Assign a government program manager**
- **Develop alternative business models, e.g.**
 - Consortium of small businesses
 - Use SBIR systems integration contacts
 - Partnership with larger defense contractor as integrator
 - Government as integrator
- **Provide alternative research approaches to standard programs**
 - Army Land Warrior Program is an example where a parallel development program may have been useful

RAND

The current model for the DoD SBIR program identifies hundreds of stand-alone topics per year (926 in 2003) and averages about two Phase I awards per topic. In general, these topics are not generally connected or integrated, other than in the broadest sense that they derive from DoD's technology goals.

One possible way for DoD to more quickly gain tangible value from the SBIR program is to use it as a resource for longer-term development projects that address specific requirements for new products, systems, or processes. Project budgets would consist, at least in part, of SBIR funding with this policy option. Advanced technology demonstrators and smaller acquisition development programs (less than \$20 million) are the types and sizes of projects that might be successfully resourced through the SBIR program. This level of effort would most likely require the assignment of a dedicated project manager.

There are a number of potential business models that could be employed by an innovative program manager. In the consortium model a number of small businesses would agree to work cooperatively toward the

larger goal. The consortium model is somewhat problematic in terms of making the coordination work and in meeting the SBIR program competition guidelines. A better model may be to use a SBIR contract to establish a small business as the program's system integrator. A variation on that model would be to use non-SBIR money to enlist a larger prime contractor as the system integrator. This approach would have the dual advantage of engaging an experienced integrator and introducing a number of SBIR award winners to DoD's prime contractor industrial base. Finally, the program office itself could take on the role of system integrator, probably with the assistance of a government laboratory or R&D center.

The following example helps to demonstrate this option. While the SBIR program was not a significant source of funding for the Army's Land Warrior program, the Land Warrior program nevertheless offers an analogy of how the SBIR program might be used to fund larger programs. The Land Warrior program office initially awarded a development contract to a large, traditional defense contractor in the mid-1990s. After several years, the program manager decided that the Land Warrior program was not progressing as required and needed a new start. Rather than sign up a different large contractor, the program manager eventually enlisted the services of Exponent, a small Silicon Valley-based company, for development of a Land Warrior prototype system based primarily on commercial technologies. Exponent relied on a number of other small businesses to provide much of the hardware and software required. In a relatively short time, Exponent and its group of small business partners successfully demonstrated a prototype system. Had it been planned, SBIR contracts could have fairly easily been used to support the program after Exponent was brought in as the Land Warrior prime contractor. SBIR contracts could also have been used to contract with Exponent for its initial concept development task and then later for its role as systems integrator.¹²¹

¹²¹ The example of the Land Warrior program is based on interviews conducted by author Bruce Held and other RAND researchers as part of a case study of the Land Warrior program during FY 2000 and FY 2001. These interviews were with Land Warrior program personnel, including the two program managers assigned over the course of the study. Additional interviews with personnel from Exponent and its subcontractors were also conducted during the same period.

An interesting application of this option would be to create a competing development track for some acquisition program or technology demonstrator. For example, in the case of the Land Warrior system described above, the SBIR program could have been used in parallel with the original development program. Such an approach would have provided the program manager two different prototype systems. The ongoing competition would probably have caused the competing development teams to approach the program in a different manner as they looked for ways to outdo their competition.

***Policy Option:
Involve the Large Defense Primes in the SBIR Program***

- **Early system prime contractor involvement in the SBIR program could improve opportunities for including SBIR developed technologies and products in defense applications**
 - Topic suggestions to identify upcoming needs
 - Proposal evaluation to identify promising projects and companies
 - Mentorship and partnership
 - Align prime contractor incentives to encourage collaboration with the SBIR program
- **Safeguards required to ensure equity and compliance with procurement law**

RAND

Due both to the nature of the technologies and products appropriate to the SBIR programs and to the resources available to them, many small businesses may find it much simpler to market the results of their SBIR projects to the larger system prime contractors for integration into larger DoD systems rather than directly to DoD itself.¹²² Therefore, we recommend examining whether system prime contractors could become more involved in the DoD SBIR program. The potential for system prime contractor involvement exists on both sides of the SBIR relationship.

On the government side, such involvement could be as simple as interacting with the system prime contractors to better understand what technologies they are likely to require in coming years. Generating SBIR topics that specifically address those needs will increase the probability that the DoD SBIR program will develop technologies and products useful to larger defense acquisition programs. Using the system

¹²² For example, the sample of SBIR topics listed in footnote 101 included an antenna, technology for fuzes, a self-aiming laser acoustic target designator/classifier and embedded smart sensor electronics for remote sensing, all of which are suggestive of component technology that could be integrated into larger systems.

prime contractors in the SBIR proposal evaluation process may be even more valuable. In this role the contractors could comment on the technical merit of the proposals, identify the potential to integrate the proposed technology or product into their larger systems, and evaluate the promise of the proposing small businesses as future subcontractors. Involving the system primes in this manner requires managing their contracts to incentivize their participation in the SBIR program. Potential incentives for them include small business goals, additional fees, and making SBIR participation a source selection factor.

On the small business side of the SBIR contract, the system primes could play a more active role through partnering arrangements. We envision arrangements in which the system prime contractor owns a minority stake in a small business that competes for SBIR awards.¹²³ Combining a minority ownership stake with a R&D collaboration contract between the system prime contractor and the small business could serve to strongly link the independent research and development (IRAD) of the larger partner with SBIR-related research undertaken by the small business.¹²⁴ In this kind of arrangement, the system prime contractor is motivated by its ownership share in the small business to commercialize the results of SBIR projects by integrating the results into its larger programs. Since the system primes conduct IRAD in an effort to develop more marketable products for their DoD customer, linking their IRAD and SBIR research also improves the potential for transfer of SBIR results into defense-related systems.¹²⁵

¹²³ For SBIR purposes a small business need only be "51% owned and controlled by one or more individuals who are citizens of, or permanent resident aliens in, the United States." There is no limitation on ownership of the other 49 percent (U.S. Small Business Administration, 2002). The concept of a larger prime system contractor owning a share of a small SBIR business is analogous to the common cross holding pattern of business relationships Japan known as "keiretsu" (Leechor, 1999).

¹²⁴ For the purposes of this report, IRAD is R&D conducted independently by defense contractors and not under contract with DoD. Defense contractors are generally allowed to allocate a portion of their overhead expenses to IRAD.

¹²⁵ Not all the possibilities outlined here are compatible with each other. For example, system prime contractors that own minority stakes in companies competing for SBIR awards would not be able to

Simpler arrangements between system prime contractors and small businesses are also possible. These include preferred vendor plans, joint R&D ventures, and mentoring programs, such as the DoD Mentor-Protégé program. Essentially, any positive relationship between a system prime contractor and a SBIR business has the potential to improve the possibility that SBIR-developed technology and products will be integrated into systems being developed for DoD.

Managing arrangements in which the system prime contractors are involved in the SBIR program requires careful attention to prevent conflicts of interest and ensure fundamental equity in the selection of SBIR awardees, as well as compliance with the statutes and regulations governing the SBIR program and government procurement. By taking advantage of the inherent flexibility in the SBIR program, though,¹²⁶ inventive and productive collaboration between the larger system prime contractors and the SBIR participants is possible.

participate or advise in SBIR award decisions due to inherent conflicts of interest.

¹²⁶ The SBIR program could be made even more flexible through innovative contracting. For example, the "other transaction" (OT) is an R&D agreements tool that is defined in the negative as *not* a contract, grant, or cooperative agreement (10 USC 2371). This means that, for the most part, the Federal Acquisition Regulations do not apply to OTs. As a result, OTs are very flexible tools for establishing relationships between contractors and the government, since most of the contracting rules established by the Federal Acquisition Regulations do not apply. Since the SBIR program is an R&D program, OTs could be used instead of contracts to make SBIR awards that include provisions not usually allowed in federal contracts.

Suggested Outcome Metrics

- **Continue to refine and use the Commercialization Achievement Index (CAI)**
- **“Time-to-Use” index**
 - Time-to-Phase III time measurement
 - Establish a Time-to-Use index for returning proposers
- **Establish a “DoD-Use-of-SBIR” index**
 - Track DoD contracting by previous SBIR award winners
 - Track subcontracts on large prime contracts by previous SBIR award winners
- **Identify and track # of first-time SBIR award winners**
- **Identify and track SBIR-related patents**

RAND

As we discussed earlier, the primary measures of today’s SBIR program are input metrics: how much money is spent, how many topics are written, how many awards per topic, and the number of new DoD contractors. Understanding how well the SBIR program is performing and adjusting the program processes and strategies to improve the program requires that program outputs also be measured effectively. The CAI that was established a few years ago is a good start. Undoubtedly, there are ways in which the index could be improved through audit and standardization of reporting, but as it currently stands, the CAI provides some indication of commercialization success for SBIR efforts. Since the thrust of our recommendations aims to improve the SBIR program’s value to DoD, most of the additional metrics we suggest are aimed at measuring the program’s return to the department.

Time-to-use data should be reasonably simple to collect and quantify. Phase I to Phase III time should be a simple datum too. Presumably, when a contracting officer designates a contract as Phase III, there is some earlier SBIR project(s) from which the Phase III

award results. Since the DD350 database contains the start date for all SBIR contracts, the time to Phase III is a straightforward calculation.

A time-to-use index could also be established to supplement the existing commercialization index. Returning SBIR proposers could be required to identify how long commercialization took. Again, these data should be relatively simple to collect, since these proposers are already required to identify cash flows that result from earlier SBIR awards.

A DoD "Use-of-SBIR" index would be useful in understanding how the research results of the SBIR program are returned to the department. This information is already partially collected as Phase III award data. Additional information could be gleaned and incorporated by tracking the progress of SBIR award winners in terms of gaining other non-SBIR DoD contracts. While the data are more difficult to gather, a final component of the DoD Use-of-SBIR index should capture the degree to which SBIR award winners are active as subcontractors to DoD prime contractors. This metric would help create a clearer picture of the SBIR program's effectiveness in terms of the commercialization and innovation benefits to DoD.

Since expanding the market of DoD contractors and improving the U.S. defense industrial base are important goals of the DoD SBIR program, an essential subset of the DoD Use-of-SBIR index would be the population of companies that get their DoD start through the SBIR program. Identification of these companies should continue, but additional metrics to track their progress within the defense industrial base should be maintained.

Finally, metrics that measure innovative activity resulting from the DoD SBIR program should be established. The most obvious of these would be to track patents that are a result of DoD SBIR projects. To be effective, such a metric will probably need to be instituted with policies that provide incentives for or actually require identifying on patent applications any relationship between the invention and the SBIR program when such a relationship exists.

CONCLUSIONS***Outline***

- DoD SBIR program and history
- DoD SBIR goals and metrics
 - DoD's evaluation of current goals
 - RAND's evaluation of current goals
- Other RAND findings
- Improving the DoD SBIR program
- **Conclusions**

RAND

In conclusion, we provide some final thoughts.

Conclusions

- **The DoD SBIR program is generally meeting the broad legislative goals established in the Small Business Innovation Development Act of 1982**
- **The significant DoD SBIR program growth suggests that it is time to reexamine the program's focus**
 - **Management of the DoD SBIR program remains focused on compliance**
 - **Therefore, resources and high-level leadership attention are inadequate for exploiting the program's R&D outcomes**
- **Carefully targeted investment that refocus and improve program management, along with more leadership emphasis, could significantly improve the return from the SBIR program for DoD**

RAND

Our examination of DoD's own measures of the SBIR program, as well as our own evaluation of available measures, leads to the conclusion that the program is generally meeting the very broad legislative goals set out for it in the enabling legislation of the governmentwide program 20 years ago. However, these goals are vague and only indirectly related to DoD's national security mission.

In the 20-plus years the DoD SBIR program has existed, its budget has grown by a factor of more than 30 in real terms. At nearly \$1 billion a year, it is now a very substantial source of R&D funds. Despite this, our impression is that throughout most of the department, management of the program remains focused primarily on compliance. There are few resources and little high-level management effort dedicated to extracting value from the SBIR program. Getting extra value out of the program will require more R&D leadership attention and greater acceptance of the DoD SBIR program as an R&D tool. In other words, the program must be managed less as a "tax" on the department's R&D efforts and more as a resource to be exploited. If this can be accomplished, the payoff in tangible benefits could be significant.

APPENDIX A. USING DD FORM 350 DATA

The DD Form 350 Is a Useful Source of Information on the SBIR Program

- **Contracting Office**
- **Contractor (name, codes, address, parent)**
- **Type of Business (small, minority, women owned, etc.)**
- **Contract Dates**
- **Contract Amount**
- **Type of Contract (R&D, procurement, other services)**
- **SBIR Program by Phase**

RAND

The DD Form 350 is a data form used to collect information about each contract, and contract modification, that DoD enters into and that obligates or de-obligates the government by \$25,000 or more.¹²⁷ In its current iteration, the form has 95 separate data fields, many of which were very useful to the current study. These include fields that identify the contracting office and contractor involved with the contract. In addition, information about the contract itself and the amount, dates, and purpose are included. Most importantly for the purposes of this study, the DD Form 350 records whether a contract belongs in the SBIR program and, if so, identifies the specific phase of the program.

¹²⁷ U.S. Department of Defense (2005e).

Using DD Form 350 Data Requires Significant Database Management

- **The DD350 database is available for download as a compressed text file from the DoD's Directorate for Information Operations and Reports**
- **The file for each year is very large**
 - **Uncompressed – 344 megabytes (FY2003)**
 - **589,238 contract records in FY 2003**
- **Microsoft's Access and Excel software used to manage DD350 data**
- **The DD Form 350 itself and contractor identification data changed over time**

RAND

Managing the DD Form 350 data remained a challenge throughout the project, primarily because of the large amount of data available. DoD's Directorate for Information Operations and Reports maintains the DD350 databases as text files that must be converted to a more useable form.¹²⁸ These files are very large. For example, the uncompressed FY 2003 database is 344 megabytes and records almost 600,000 contract actions. We found that conversion of the text file into a Microsoft Access database was the easiest way to manage the entire data set. Subsets of the DD350 could also be managed and easily manipulated in Microsoft Excel.

Perhaps the most challenging aspect of using the DD Form 350 data is that both the form itself and the contractor identification data change over time. Thus, some restructuring of the databases was required to manage the data from year to year. Since the identification of contractors in the database was not stable, the essential task of tracking SBIR award winners over time was rather difficult.

¹²⁸ U.S. Department of Defense (2005d).

Companies in DD350 Require Manual Tracking to Capture Contracting Activity Over Time

- Companies have numerous identities in the DD350 database, e.g., Creare Inc.

- 3 contractor ID #s

- 5 CAGE codes

- 3 company names

- 13 combinations of these identifiers in the DD350 database

- All SBIR contractors identified and manually collated to allow tracking over time

Contractor ID #	CAGE Code	Company Name
018917153	8A287	CREARE RESEARCH & DEVELOPMENT
072021041	0N1Z2	CREARE INC
072021041	6V577	CREARE INC
072021041	8A287	CREARE INC
072021041	8A287	CREARE INCORPORATED
072021041	8A278	CREARE INCORPORATED
072021041	8A287	CREARE INCORPORATED
072021041		CREARE INCORPORATED
07303114J	0N1Z2	CREARE INC
07303114J	8A287	CREARE INC
07303114J	81287	CREARE INCORPORATED
07303114J	8A287	CREARE INCORPORATED
07303114J		CREARE INCORPORATED

- SBIR companies were tracked from FY 1990 to FY 2003

RAND

When we started to identify SBIR contractors in the DD350 database we found that each company could be identified in a number of ways. These included a contractor identification number, a Commercial and Government Entity (CAGE) code (through FY 2000), a company name, and a company address. Unfortunately, for companies that contracted with DoD over a number of years, these various identifiers tended to change, either entirely, through typos, when there was no standard format (as in the company name), or, in the case of addresses, when the company moved location. Creare Inc., for example, was apparently assigned three contractor identification numbers. We also found instances of five CAGE codes (at least two of which appear to be typos) and three different conventions for naming the company on the DD Form 350. There were also variations of the company's address.

To track companies like Creare through time, we were forced to use manual methods of "sort and identify" in order to give a common company identifier in every found instance of a contract to a particular company. This manual collation was started for the FY 1990 data and was

continued through the FY 2003 DD350 database. Once done, the common company identifiers allowed automated tracking of each DoD SBIR award winner during those years.

APPENDIX B. MINI-CASE STUDIES



NATIONAL DEFENSE RESEARCH INSTITUTE

***Mini-Case Studies: A Random Sample of
40 1995 First-Time DoD SBIR Winners***

One of the major limitations of any study of the DoD SBIR program is that little data have been collected about the companies that win SBIR awards. And the little information that is available has a number of problems. While DoD makes note of specific "success stories," these tend to be few in number, anecdotal, and, as the name implies, focused only on those companies that have a reportable success. The department now collects commercialization data about previous SBIR award winners, but this information is limited to those companies competing for additional SBIR Phase I awards and consists of only self-reported, non-audited information. Finally, some case studies have been accomplished by previous SBIR program research, but these have also tended to be few in number and thus fail to provide much sense of how the DoD SBIR award winners can be characterized as a whole.

To help us gain some insights into how the DoD SBIR program broadly affects the companies that win Phase I awards we decided that some sort

of case study analysis was necessary. Unfortunately, because this research project had very limited resources (time and money), we were forced to limit the scope of the case study analysis. As a result, we chose to focus on only one DoD SBIR class, the class of 1995.¹²⁹ From that class of 254 companies we randomly selected 40 companies as case study candidates. Case studies are typically detailed and time intensive. Since we did not have the resources for a detailed examination of 40 companies, we opted to do a more superficial assessment. Such an assessment was undertaken with the acknowledgment that any characterization of the group that we developed would represent a minimal assessment of the group's achievements. In other words, we acknowledge that a more rigorous investigation would undoubtedly uncover more information and that information would most likely improve the perceived successes of this group of companies. For this review, we conducted Internet searches and accessed the Central Contractor Registry (CCR),¹³⁰ TECH-Net,¹³¹ and the USPTO databases.

¹²⁹ We define a class as being the set of companies that enter the DoD market through the SBIR program in a particular year. For example, the class of 1995 includes the companies whose first DoD contract was an SBIR contract in FY 1995.

¹³⁰ "The Central Contractor Registration (CCR) is the primary vendor database for the U.S. Federal Government. The CCR collects, validates, stores and disseminates data in support of agency acquisition missions" (*Central Contractor Registration Handbook*, 2004).

¹³¹ "Tech-Net is an Internet-based database of information containing Small Business Innovation Research (SBIR) awards, Small Business Technology Transfer (STTR) awards, Advanced Technology Program awards, and Manufacturing Extension Partners (MEP) centers" (U.S. Small Business Administration, 2005c).

Company Characteristics DoD SBIR Class of 1995

- **16 companies had current Web sites**
- **24 companies had a CCR entry; only 9 were active**
- **Founding dates were established for 28 companies**
 - **Average date of founding - 1994**
 - **14 of 28 were founded after 1993**
- **13 companies identified as a patent assignee or the company founder is listed as the inventor**
 - **104 total patents**
 - **3 firms founded after 1993 had 34 patents**
 - **Firms with patents were bought out or became commercial successes with a greater probability**

RAND

Our initial Google search found that 41 percent (16 of 39) of the firms had active Web sites. These Web sites were valuable sources of information concerning the firms and their current product or service range.¹³²

Twenty-four of the companies were included in the CCR, although only nine had currently active entries. Since all contractors conducting business with the federal government are required to register with the CCR and renew that registration on an annual basis, we interpret the nine active CCR entries as indicating that approximately one-quarter of the companies in our sample have some intent to continue doing business with the government in the current year.

Information found in the CCR and on company Web sites provided founding dates for 28 of the companies. The average company age at the time of SBIR award is four years. Fourteen of these 28 companies were

¹³² The study team eliminated one company from the list of 40 when we learned that it was incorrectly identified. Briscoe Consulting of Oklahoma was erroneously listed as Brimrose Corp. Founded in 1979, Brimrose won its first DoD SBIR in 1984; therefore, it was not part of the class of 1995.

founded after 1993. The oldest firms, Ionic Systems Inc. and Materials Behavior Research, were founded in 1979. The remaining 12 companies were founded between 1986 and 1992.

We searched the USPTO database for patents that had these 39 firms as assignees or had a key employee listed as an inventor. We found that 13 firms had 104 patents assigned or had listed the company founders as the inventor. Of the firms founded after 1993, three had 34 patents attributed to the firm or to the firm's founder.

Selected Companies Characterized

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. <u>GENERAL REALITY</u> 2. <u>PVD PRODUCTS INC</u> 3. <u>GRAYCHIP</u> 4. <u>KIONIX INC</u> 5. <u>MERRITT SYSTEMS INC</u> 6. <u>PHOENIX SCIENCE & TECHNOLOGY</u> 7. <u>NEW ERA TECHNOLOGY INC</u> 8. <u>A Z TECHNOLOGY INC</u> 9. <u>SYSTEM TECHNOLOGY ASSOCIATES</u> 10. <u>IONIC SYSTEMS (INC)</u> 11. <u>BODKIN DESIGN ENGINEERING</u> 12. <u>APPLIED PULSE TECHNOLOGY</u> 13. <u>RELIABLE SOFTWARE TECHNOLOGIES</u> 14. <u>FISHMAN CONSULTING</u> 15. <u>XINETICS INC</u> 16. <u>NEUROPHYSICS CORP</u> 17. <u>APPLIED SIMULATIONS, INC.</u> 18. <u>BIODE, INC</u> | <ol style="list-style-type: none"> 20. <u>STANDARD OBJECT SYSTEMS INC</u> 21. <u>MATERIAL'S BEHAVIOR RESEARCH CORP</u> 22. <u>INTERNATIONAL DESIGN MODELING</u> 23. <u>INNOVATIVE RESEARCH AND TECH</u> 24. <u>CENTRE INTERNATIONAL BUSINESS</u> 25. <u>INNOVATIVE LASERS CORPORATION</u> 26. <u>AFAB TECHNOLOGIES INC</u> 27. <u>RELIABLE COMPUTER TECHNOLOGIES</u> 28. <u>EAST INC</u> 29. <u>NEURAL TECHNOLOGY INC</u> 30. <u>FIBER OPTIC FABRICATION INC</u> 31. <u>TECHNOLINK</u> 32. <u>INTELLIGENT INVESTMENT</u> 33. <u>CHEN, E & ASSOCIATES</u> 34. <u>OPTOELECTRIC</u> 35. <u>PRIMO OPTICS INC</u> 36. <u>ENGINEERING TECHNOLOGIES ASSOC</u> 37. <u>ADEPT IC DESIGN</u> 38. <u>3C SEMICONDUCTORS (INC)</u> 39. <u>METROLOGY RESEARCH & DEV</u> 40. <u>MEDICAL THERMAL DIAGNOSTICS LL</u> 41. <u>BRIMROSE CORP (Dropped)</u> |
|---|---|
- Acquired/Merged
Current Defense & SBIR Contractor
On-Going Commercial Business
Out of Business

RAND

Based on the information obtained in our Internet search we categorized each firm as Acquired/Merged, Current Defense & SBIR Contractor, Ongoing Commercial Business, Uncharacterized Business, or Out of Business. We next discuss each group in greater detail.

Companies Acquired/Merged DoD SBIR Class of 1995

- **Five of forty companies were acquired by or merged with another company**
 1. **Kionix — 4 SBIR awards, 18 patents**
 - Acquired by Calient in 2000
 2. **Graychip — 1 SBIR award, 3 patents**
 - Acquired by Texas Instruments in 2001
 3. **PVD Products — 8 total SBIR awards, 12 patents**
 - Merged with Epion in 1996
 4. **Geometrix/General Reality — 14 SBIR awards, 9 patents**
 - Merged with Vroom.com to become Irealty in 1999
 5. **Merritt Systems**
 - Acquired by Rohwedder AG in 2000
- **The companies that were acquired or merged had, on average, more patents**
 - Acquired/merged – 10.5; current defense cont. – 1.7; commercial business – 6; others – 0.7

RAND

From our research, we determined that four companies of our sample were either acquired or merged.

The first, Kionix, a producer of micro-electro-mechanical systems, was founded in 1993 in Albany, New York, and merged with TMS Technology in 1995 after winning a \$761,000 SBIR contract in the same year. TMS Technology was acquired by Calient in 2000, although it was spun off shortly thereafter. According to the press releases on TMS Technology's Web site, the company has received \$28 million in venture capital. The founders are credited with 18 patents, while the company claims control of 210 patents in total.

The next company, Graychip, a maker of analog wireless chips, was founded in 1989 and won a \$60,000 SBIR Phase I in 1995. Texas Instruments acquired the company in 2001. The company's founder, Joe Gray, is listed on three patents.

The third company, PVD Products, is a maker of pulsed laser deposition systems. It was originally spun off from Raytheon in 1995. According to the company's Web site, the founder used \$1.2 million in 1995 SBIR awards to commercialize its pulsed laser deposition systems.

PVD Products merged with Epion in 1996. The company's founder, James A. Greer, is listed on 12 patents.

General Reality is a virtual reality interface designer and was founded in 1996. General Reality was acquired by VroomCom in 1999, which then adopted the name Ireality. One of the principal investigators, Arthur Zwern, has eight patents. In the DD350 database, General Reality and Geometrix, a firm focusing on three-dimensional facial recognition systems, share a CAGE code (Zwern is the president and founder of both). Geometrix has won five SBIR awards for \$1.4 million, while General Realities won eight DoD SBIR contracts for \$2.7 million.

Merritt Systems of Florida is listed by NASA as a SBIR success story for the development of a parking garage automation system. The registered trademark SmartSensor, which was associated with the parking garage automation system, is now owned by Wavetronics of Utah and is associated with a similar system for counting traffic flow across streets, perhaps indicating the sale of the intellectual property rights. Merritt Systems won two DoD SBIR awards for \$700,000 and six NASA SBIR awards for \$1.3 million. The company was acquired in 2000 by Rohwedder AG, a German company.

It is notable that each of these companies had founders who patented innovations with several companies. None of the companies seemed to rely solely on SBIR contracts for revenues, nor did they win significant standard defense contracts. Three companies (Kionix, PVD Products, and Geometrix) were relatively new firms at the time of their first SBIR award.

This group of companies was interesting in that it had the highest average patent count (10.5 per company).

Current Defense & SBIR Contractor DoD SBIR Class of 1995

- **Seven of the forty companies appear to be primarily SBIR contractors**
 - **Three small disadvantaged businesses**
 - **New Era Technologies – Woman-owned business – \$2M SBIR**
 - **AZ Technologies – Woman-owned business – \$6.6M SBIR; 1 non-SBIR DoD contract for \$323K in 2003**
 - **System Technology Associates – 8(a) – \$70K SBIR**
 - **Four small contractors**
 - **Phoenix Science and Technology – \$4.3M SBIR**
 - **Bodkin Design Engineering – \$941K SBIR**
 - **Ionic Systems – \$3.6M SBIR**
 - **Applied Pulse Technology – \$267K SBIR**

RAND

Seven of the 40 companies appear to be primarily defense, or other federal, contractors. These companies seem to rely heavily on the SBIR program for their contracts. Three of these companies are also small disadvantaged businesses.

The first of the three small disadvantaged businesses is New Era Technology of Gainesville, Florida. It was founded 1988 and is a certified woman-owned business. The company has won four DoD SBIR awards worth \$669,000 and another five SBIR contracts worth \$1.3 million from other federal agencies.

AZ Technologies of Huntsville, Alabama, was founded in 1990 and has won 32 SBIR awards totaling \$6.6 million from DoD and NASA. It is a certified woman-owned business and service-disabled veteran-owned business. Its products and services include optics, information technology, materials and coatings, and engineering services. AZ Technologies won a lone non-SBIR contract for \$300,000 in 2003, according to our DD Form 350 analysis.

The third small disadvantaged business in this list is System Technology Associates (listed as Harold Buie in DD350 database), a

certified 8(a) business with a projected graduation from the 8(a) program in 2005. According to their CCR entry the company was founded in 1987 and provides a number of services, from engineering to janitorial. System Technology Associates won a single \$70,000 Phase I in 1995. We saw no other entries in the DD350 database that would indicate other DoD work.

Of these three small disadvantaged businesses, we could find no patents, nor had the businesses won any significant non-SBIR defense prime contracts.

The first of the non-small disadvantaged businesses, Phoenix Science and Technology of Arlington, Massachusetts, is a pulse acoustic and light laboratory. It was founded 1994 and has won 18 DoD SBIR awards for \$3.1 million and nine other federal SBIR awards for \$1.1 million. In addition, the company was awarded a single non-SBIR DoD contract in 2002 for \$160,000. An employee, Raymond Schaefer, is listed on five patents.

The next company in this category is Bodkin Design Engineering of Needham, Massachusetts. This company, founded 1992, specializes in electro-optic and mechanical engineering. DD350 analysis indicates a total of three DoD SBIR awards, one in 1995 followed by two more in 2002, worth \$941,000. The TECH-Net database lists a total of four DoD SBIR awards for \$1.7 million, probably indicating an additional Phase II award not captured in the DD350 analysis.

Ionic Systems Inc. of San Jose, California, has won 17 total federal SBIR awards for \$3.5 million, although we identified no other DoD contracts. The company also has six patents assigned to it.

Applied Pulse Technology of San Diego, California, is a small R&D consulting firm. It has won three SBIR awards totaling \$267,000.

Ongoing Commercial Business DoD SBIR Class of 1995

- **One start-up aided by SBIR award**
 - NeuroPhysics - \$20M in VC money to date
 - Founded to win 1995 Army SBIR award
- **Two commercial successes linked to SBIR awards**
 - Xinetics - \$13.5 in federal SBIR; \$4.1M non-SBIR DoD contract
 - Reliable Software Engineering
 - Founded to win 1992 NASA SBIR
 - 1995 DARPA awards sustained business in early stage
- **Two primarily non-defense, service firms testing the water**
 - Fishman Consulting - 1 Phase I in 1995
 - Applied Simulations - 2 Phase I's in 1995
- **One primarily non-DoD contractor**
 - Biode - \$5.2M in non-DoD SBIR

RAND

We classified six companies as ongoing commercial businesses. Of these, we determined that the DoD SBIR program had a direct impact on the founding strategy and ultimately the commercial success of three firms.

NeuroPhysics Corporation of Shirley, Massachusetts, is the first firm we judged to have used DoD SBIR contracts in its start-up strategy. The company was founded in 1995 "to do U.S. Army and NIH [National Institutes of Health]-funded research on medical applications of near infrared spectroscopy (NIRS) technology."¹³³ Since its founding, NeuroPhysics has attracted \$20 million and has won \$1.4 million in five SBIR awards from DoD and NIH. Interestingly, the company's current products, from a technology standpoint, do not appear tied to its early SBIR awards.

In the case of two companies, Xinetics and Reliable Software Engineering (later Cigital), we found direct evidence that their current

¹³³ NeuroPhysics Corporation (2005).

commercial product successes were directly tied to the SBIR program.¹³⁴ Xinetics was founded in 1993 and has won 32 SBIR awards—19 from DoD and 13 from NASA—totaling \$13.5 million. The company also won \$4 million in non-SBIR contracts from DoD, the second highest total in our sample. Mark Early, a founder of Xinetics, noted that research conducted under SBIR found its way into products the company sells to defense prime contractors. While we did not learn the extent of those contracts, the company's Web site notes that Xinetics employs 49, mainly professional, personnel. In 2003 Xinetics won a little over \$3 million in DoD contracts (including SBIR). The size of the payroll suggests that the company is earning several million dollars per year more through commercial sales.

Reliable Software Technologies is a software security and reliability firm in Dulles, Virginia. It was founded in 1992 and has won six SBIR awards from DoD, Department of Commerce, and NASA. While its first DoD SBIR award was made in 1995, the company won its first SBIR award three years earlier in 1992. The company's founder noted that these early SBIR awards were important factors in establishing the company's product and service lines, as well as its in-house expertise and external reputation. Cigital has won a total of \$7.7 million in non-SBIR DoD contracts, giving it a higher non-SBIR total than all other contractors combined have in our sample.

We also found examples of two companies that are commercial successes, although we cannot establish that the DoD SBIR program played a significant role in that success. Fishman Consulting of Palo Alto, California, is an enterprise network consulting firm that won a single DoD SBIR Phase I award in 1995. Applied Simulations is a compressible flow-modeling firm that won two SBIR awards, a Phase I in 1995 followed by a Phase II in 1997. According to its Web site, Applied Simulations seems to have an active business modeling airflow patterns for NASA, DoD, and even NASCAR.¹³⁵ Both of these companies seem to be service

¹³⁴ These two examples were discussed earlier in the main body of this documented briefing.

¹³⁵ Although we could not find contracts with DoD in the DD350 database. This may mean that the work for DoD is completed as a subcontract or is managed on contracts of less than \$25,000. It is also possible that the database contract identifiers for Applied Simulations

oriented rather than research oriented. Neither has any patents identified, nor do they list research papers or technical innovations on their Web sites.

Biode of Westbrook, Maine, which makes viscometers, is primarily a non-DoD business. It was founded 1982 and has won \$5.8 million from 24 SBIR awards from DoD, the Department of Health and Human Services, the Environmental Protection Agency, and the National Science Foundation. Only two of these awards, for less than \$700,000, have been with DoD. Biode also won a modest \$202,000 non-SBIR DoD contract.

changed in ways that prevented following the companies contracting history.

Out of Business DoD SBIR Class of 1995

- **22 companies are most likely out of business**
 - None have an active Web page or current CCR registration
 - 14 won only a single Phase 1 SBIR contract
 - 17 were very young companies in 1995 (founded after 1991)
 - 3 won non-SBIR DoD contracts
 - Fiber Optic Fabrication Inc.-\$969K in 1997
 - Intellegent Investment-\$261K in 1996
 - Chen, E. & Associates-\$356K in 1997
 - Medical Thermal Diagnostics was a NASA SBIR Success Story
- **The companies that went out of business made much less use of the DoD SBIR program – average \$0.47M vs. \$1.4M**

RAND

Of the 40 companies we looked at, 22 are not very likely to still be in business. None have an active Web site or current CCR registration. Similarly, none have any indicated non-SBIR DoD contracting activity in the last six years. This is not surprising, since a majority of these companies (14) won only a single DoD SBIR Phase I contract and had no other activity. Where we could establish a founding date, we noted that all except one of these companies were founded after 1991. Only three of the group (Fiber Optic Fabrication Inc., Intelligent Investment,¹³⁶ and E. Chen & Associates) won any non-SBIR DoD contracts. These contracts were all relatively small and occurred within two years of the companies winning their first DoD Phase I SBIR award. Interestingly, one of these companies, Medical Thermal Diagnostics, was one of only two SBIR “success stories” identified in the group of 40. That success was with a NASA, not a DoD, SBIR project, however.

¹³⁶ We included Intelligent Investment in this categorization because we could find no current information about the company. The company did receive a Phase I SBIR award as late as 2001, however.

These businesses made much less use of the DoD SBIR program. On average, these companies were awarded less than half a million dollars in DoD SBIR contracts, while the other categories in the class of 1995 averaged almost \$1.5 million in DoD SBIR contracts.

Case Studies

DoD and SBIR Contracting

	Year DoD Contract	Total DoD Contract \$1000s	Phase 1	Phase 1 \$1000s	Phase 2	Phase 2 \$1000s	Total DoD SBIR \$1000s	TechnNet Total DoD SBIR Awards	Other SBIR Awards	TechnNet DoD SBIR \$1000s	Other SBIR \$1000s	Total SBIR Awards	Total SBIR \$1000s
GENERAL REALITY/GEOMETRIX	2003	384	4	298	9	2,848	3,145	8	1	2,660	100	14	3,245
PVD PRODUCTS	1996	0	4	349	4	894	1,243	2		900		8	1,243
GRAYCHIP	1995	0	1	62			62	1		62		1	62
KIONIX	1999	68,091	4	761			761	5		904		4	761
PHOENIX SCIENCE & TECHNOLOGY	2002	170	6	434	12	2,742	3,176	8	9	2,468	1,144	27	4,320
NEW ERA TECHNOLOGY	2002	0	2	170	2	500	670	2	5	170	1,340	9	2,010
A Z TECHNOLOGY	2003	323	6	574	8	2,222	2,796	14	18	6,234	3,826	32	6,622
SYSTEM TECHNOLOGY ASSOCIATES		0	1	70			70	1		70		1	70
IONIC SYSTEMS	2002	0	4	266	1	699	965	5	12	966	2,625	17	3,590
BOOKIN DESIGN ENGINEERING	2002	0	2	194	1	747	941	4		1,695		3	941
RELIABLE SOFTWARE TECHNOLOGIES	2002	7,726	5	473	5	2,017	2,490	3	3	698	319	14	2,809
FISHMAN CONSULTING	1995	0	1	60			60	1		60		1	60
XINETICS	2003	4,083	11	783	8	4,280	5,063	10	13	1,087	8,431	32	13,493
NEUROPHYSICS	1997	0	3	561			561	2	2	561	845	5	1,406
APPLIED SIMULATIONS	1996	0	1	82	1	190	272	2		682		2	272
BIODE	1996	203	3	669			669	2	22	670	5,208	25	5,877
APPLIED PULSE TECHNOLOGY	2002	0	3	267			267	3		268		3	267
MEDICAL THERMAL DIAGNOSTICS	1997	375	1	100	1	375	475			850		2	475

Case Studies

DoD and SBIR Contracting

	Last DoD Contract	Total DoD Contract \$1000s	Phase 1	Phase 1 \$1000s	Phase 2	Phase 2 \$1000s	Total DoD SBIR \$1000s	Technet Total DoD SBIR Awards	Other SBIR Awards	Technet DoD SBIR \$1000s	Other SBIR \$1000s	Total SBIR Awards	Total SBIR \$1000s
GENERAL REALITY/GEOMETRIX	2003	384	4	298	9	2,848	3,145	8	1	2,660	100	14	3,245
PVD PRODUCTS	1996	0	4	349	4	894	1,243	2		900		8	1,243
GRAYCHIP	1995	0	1	62			62	1				1	62
KIONIX	1999	68,091	4	761			761	5		904		4	761

RELIABLE SOFTWARE TECHNOLOGIES	2002	7,726	5	473	6	2,017	2,490	3	3	698	319	14	2,809
FISHMAN CONSULTING	1995	0	1	60			60	1		60		1	60
XINETICS	2003	4,083	11	783	8	4,280	5,063	10	13	1,087	8,431	32	13,493
NEUROPHYSICS	1997	0	3	561			561	2	2	561	845	5	1,406
APPLIED SIMULATIONS	1996	0	1	82	1	190	272	2		682		2	272
BIODE	1996	203	3	669			669	2	22	670	5,208	25	5,877

STANDARD OBJECT SYSTEMS	1999	0	6	440	4	750	1,190	8		1,680		10	1,190
MATERIAL'S BEHAVIOR RESEARCH		0	1	96	2	600	696	3		696		3	696
INTERNATIONAL DESIGN MODELING		0	1	100			100	1		100		1	100
INNOVATIVE RESEARCH AND TECH	1995	0	2	124			124	1		60		2	124
CENTRE INTERNATIONAL BUSINESS	1995	0	1	70			70	1		70		1	70
INNOVATIVE LASERS	1996	0	1	64			64	1	1	64	75	2	138
AFAB TECHNOLOGIES	1999	0	2	158			158	1	6	79	1,508	8	1,666
RELIABLE COMPUTER TECHNOLOGIES		0	3	257			257	3	1	257	49	4	306
EAST INC	1995	0	1	69	3	736	805	4	1	1,049	48	5	852
NEURAL TECHNOLOGY	1997	0	3	240			240	4		340		3	240
FIBER OPTIC FABRICATION	1997	969	3	269	2	573	843	1		100		5	843
TECHNOLINK	1996	0	1	739			739	2	2	804	293	3	1,033
INTELLIGENT INVESTMENT	2001	261,087	7	1,535			1,535	8		1,387		7	1,535
CHEN, E & ASSOCIATES	1997	356	2	140	3	992	1,132	4		1,486		5	1,132
OPTOELECTRIC	1998	0	1	61			61	2	4	110	499	5	560
PRIMO OPTICS	1995	0	1	59			59	1		59		1	59
ENGINEERING TECHNOLOGIES ASSOCIATES	1995	0	1	69			69	3		731		1	69
ADEPT IC DESIGN	1995	0	1	60			60	1		60		1	60
3C SEMICONDUCTORS		0	1	71	3	951	1,023	2		1,023		4	1,023
METROLOGY RESEARCH & DEVELOPMENT	1995	0	1	80			80	1		80		1	80

APPENDIX C. FREQUENT DOD-SBIR AWARD WINNERS, 1994-2004

NEW DOD-SBIR FREQUENT AWARD WINNERS

FAWs in the period from 1994 to 2004 were defined, somewhat arbitrarily, as those companies with 30 or more DoD SBIR contract actions listed in the DD350 contract action database in any continuous five years over the period of interest. New FAWs are those that had few or no SBIR contract actions during the first few years of the period and whose participation in the program grew significantly later in the program. These are identified in the table immediately below, along with the total number of contract actions for each company during the ten-year period.

SY Technology Inc. (bought by L-3 in 2002)	40
Scientific Research Corporation	80
Sonalysts Inc.	38
Digital System Resources Inc. (bought by General Dynamics in 2003)	155
SRS Technologies Inc.	65
Sytronics Inc.	38
Areté Associates Inc.	110
Micro Analysis and Design Inc.	62
Hypres Inc.	45
Progeny Systems Corporation	111
Innovative Scientific Solutions	61
CHI Systems Inc.	95
Trident International Inc.	107
Dynamics Technology Inc. (merged with Applied Signal in 2005)	63
RDA Inc.	40
MesoSystems Technology Inc.	32
ITN Energy Systems Inc.	48
Knowledge Based Systems Inc.	78
Spectral Sciences Inc.	46
Advanced Ceramics Research Inc.	55
Touchstone Research Laboratory	31

Senor Electronic Technology	30
Navsys Corporation	107
21st Century Systems Inc.	43
Coherent Technologies Inc.	191
Frontier Technology Inc.	97
Aptima Inc.	83
Texas Research International	129
Scientific Application & Research	104
Management Sciences Inc.	45
Architecture Technology Corporation	71
Waveband Corporation	43
Ultramet Inc.	57
Midé Technology Corporation	54
Nonvolatile Electronics Inc.	101
ThermoAnalytics Corporation	36
Triton Systems Inc.	182
Intelligent Systems Technology Inc.	42
TDA Research Inc.	76
Defense Research Associates Inc.	60
MicroCoating Technologies Inc.	69
Mohawk Innovative Technology Inc.	39
Nanopowder Enterprises Inc.	75
Combustion Institute Inc.	74
Busek Company Inc.	55
FEORC Inc.	156
Orbital Research Inc.	40
Materials Engineering & Technology	54
NanoSonic Inc.	46
Mayflower Communications Company	68
Impact Technologies LLC	56
Eikos LLC (not Inc.)	32

CONTINUING DOD-SBIR FREQUENT AWARD WINNERS

Continuing FAWs are those companies whose pattern of DoD-SBIR participation remained either relatively constant throughout the period 1994-2003 or whose participation, while varied over the period, was about as strong at the end of the period as at the beginning. Those companies we identified as "continuing FAWs" are listed in the table immediately below, along with the total number of contract actions for each company during the ten-year period.

Applied Research Associates Inc.	70
Planning Systems Inc.	87
Orincon Industries Inc. (acquired by Lockheed Martin in 2003)	159
Photon Research Associates	67
Mission Research Corporation	287
MTL Systems Inc. (acquired by CACI in 2004)	39
SVS Inc. (bought by Boeing in 2000)	45
Alphatech Inc. (bought by BAE Systems in 2004)	203
Toyon Research Corporation	98
Visidyne Inc.	48
Systems and Processes Engineering	122
Nova Engineering Inc.	52
Foster-Miller Inc. (acquired by QinetiQ [Carlyle Group] in 2004)	557
Irvine Sensors Corporation	75
Microcosm	70
Technology Service Corporation	157
Aspen Systems Inc.	47
Klein Associates Inc.	50
LSA Inc.	55
Daniel H. Wagner Associates	91
Physical Sciences Inc.	277
Systran Federal Corporation	74
Aculight Corporation	97
Tanner Research Inc.	73
Material Sciences Corporation	59

CSA Engineering Inc.	106
Sensors Unlimited Inc.	51
Flow Industries Inc.	56
Aerodyne Research Inc.	61
Barron Associates Inc.	53
Scientific Systems Inc.	138
TPL Inc.	114
Q-Dot Inc.(bought by Simtek in 2001)	65
EIC Laboratories Inc.	113
CFD Research Corporation (spun off part of the company to the ESI Group)	155
SatCon Technology Corporation	88
Creare Research & Development	205
Accurate Automation Corporation	77
Stottler Henke Associates Inc.	124
Vexcel Corporation	49
Intelligent Automation Inc.	129
MetroLaser Inc.	191
Lynntech Inc.	96
Charles River Analytics Inc.	151
Materials & Electrochemical Research	130
Cybernet Systems Corporation	146
Physical Optics Corporation	343
Kestrel Corporation	51
Cape Cod Research Inc.	60
Radiant Research Inc.	42
Mainstream Engineering Corporation	61
Brimrose Corporation of America	40
Farr Research Inc.	51
Eltron Research Inc.	49
Modus Operandi Inc.	46
Nanomaterials Research Corporation	71
Spectra Research Inc.	50
Spire Corporation	68

PREVIOUS DOD-SBIR FREQUENT AWARD WINNERS

Previous FAWs are those companies whose participation in the DoD SBIR program appeared to have ceased by 2003. Those companies we identified as Previous FAWs are listed in the table immediately below, along with the total number of contract actions for each company during the ten-year period.

Princeton Electronic Systems I (now Princeton Optronics)	39
Laser Power Corporation (acquired by II-IV Inc. in 2000)	49
Schwartz Electro-Optics Inc. (appears to have been broken up)	34
ViaSat Inc. (outgrew SBIR)	101
NZ Applied Technologies Corporation (acquired by Corning in 2000)	87
Atlantic Aerospace Electronics (acquired by Titan Corp in 1999)	62
Pacific Sierra Research Corporation (acquired by Veridian in 1998)	67
Amherst Systems Inc. (acquired by Comptek in 1999, which was acquired by Northrop Grumman in 2000)	93
ILC Technology Inc. (acquired by PerkinElmer in 1998)	60
ATMI Inc. (outgrew SBIR)	113
Tacan Corporation (now Ipitek)	65
CoreTek Inc. (acquired by Nortel Networks in 2000)	42
AbTech (now MarketMiner)	31
Silicon Mountain Design (acquired by DALSA in 1999)	50
RGS Associates Inc.	32
Gemfire Corporation	35

APPENDIX D. Questions for DoD SBIR Components

1. What *goals* does your component have for its SBIR program? Do the goals go beyond those criteria set out by the SBA to include service or component goals such as
 - a. Transformation?
 - b. Service- or component-specific R&D goals?
 - c. Bringing new performers into the DoD industrial base?
 - d. Utilization of Phase III?
 - e. Evolution of the awardees to mainstream DoD funding?
2. How do you pick the *topics* for SBIR solicitations?
3. What *selection criteria* do you use for SBIR awards?
4. What *selection process* do you use?
5. Do you weight new SBIR awardees different from *returning* SBIR awardees?
6. What processes do you use to *monitor* the performance of SBIR awards?
7. How are SBIR *results* used by your service/agency?
8. What *case studies and anecdotes* do you have related to SBIR successes and failures? How do you *measure* their success or failure? What are the metrics?

9. What *databases* do you maintain to track SBIR awards from your component? How can we gain access to the databases?
10. What kind of data do you wish you had?
11. What *lessons* have you learned about running the SBIR program to maximize the benefits to your service or component?
12. What do you not like about the SBIR program?
13. What *ideas* can you share for improving the SBIR program?
14. Are there *reports or analysis* of your SBIR program? If so, how can we obtain copies?
15. How do you follow *other organizations SBIR best practices*? How would you share yours?
16. Do you think any/many of your SBIR contractors *would have won* research contracts from your organization without the SBIR program in place? Why or why not?
17. Do you keep *track* of SBIR performers to follow their growth path after leaving the program? Do they reappear as part of your future industrial base on later programs (i.e., do you have data on or cases of SBIR contractors who also won non-SBIR contracts with your organization)? If so, do you feel that the contractor's SBIR

success had any positive (or negative) influence on their winning non-SBIR work with your organization?

18. How much *time* does your spend on SBIR contracting? How does this compare per dollar awarded to the other R&D contracts you (or your service/agency) award? What percentage of your total contract administration time is spent on SBIR contracts?

19. What other insights on your SBIR program can you offer?

APPENDIX E. SBIR Topics from the 2004.3 Solicitation**ARMY****Armaments RD&E Center (ARDEC)**

- A04-001 Rapid Q-Switching of Solid-State Lasers
- A04-002 Frame Rate Hyperspectral Target Segmentation
- A04-003 Innovative Mobile Extrusion Plant for Onsite Fabrication of
Ammunition Packaging Materials from Composite Recycled Plastics
- A04-004 Ballistically Projected Conducted Energy (Electric Stun)
Projectile
- A04-005 Adaptive Bandwidth High Power RF Antenna
- A04-006 Lubrication Free Small Arms Weapons Coatings
- A04-007 Targeting Image Sensor for Rapidly Spinning Projectiles
- A04-008 Long Storage Life Active Battery
- A04-009 Rifle Recoil Energy Reclamation Concepts
- A04-010 Innovative Wall Penetration Munition
- A04-011 Innovative Intelligent Agent and Cognitive Decision Aids
Component Technology
- A04-012 Novel High Strength, High Precision, High Ductility Warhead Case
Material
- A04-013 Novel Use of Magnesium Composites to Reduce Weight of Mortar
Systems
- A04-014 Innovative Modular Interlocking Pallet Containers
- A04-015 Explosive Detection Device
- A04-016 Super-Efficient Omni-Directional Antennas for Low Power Wireless
Ammunition "Health" Monitoring Systems
- A04-017 No-Preset Autonomous Proximity (NPAP) Fuzing-Med Cal Munitions
- A04-018 Near-Vehicle Situational Awareness and Omnidirectional Weapons
Detection System
- A04-019 Innovative Wireless, Self-Mapping Small Baseline Acoustic Array
- A04-020 Rapidly Emplaced Devices to Attach Sensors/Demolitions to
Structures
- A04-021 On-Board Recorder for Data Acquisition During Firing and Flight
of Projectiles
- A04-022 Mega-Volt X-Ray Digital Imaging Inspection System

A04-023 Microsystems Technology (MST) for Fuzing in Low-Spin/Low-G
Launch Environment

A04-024 Self-Aiming Laser Acoustic Target Designator/Classifier

A04-025 Embedded Smart Sensor Electronics for Remote Sensing

A04-026 Confined Space Blast Wave Measurement

Army Research Institute (ARI)

A04-027 Multi-Tasking Assessment for Personnel Selection and Development

A04-028 Emotional Intelligence Tools for Personnel Selection, Training
and Development

A04-029 Computer-Adaptive Assessment of Temperament to Support Personnel
Selection and Classification Decisions

A04-030 Shared Understanding Across Levels of Command

A04-031 Trust in Temporary Groups

A04-032 New Technologies for Growing Leaders: Assessment of Wisdom

Army Research Lab (ARL)

A04-033 Novel Solid State Reflective Imaging Devices for Flexible
Display Applications

A04-034 Multifunctional Ceramic Barrier Coatings for Si-Based Ceramic
Components

A04-035 Integrated Multi-Channel MHz Speed Fiber Phase Shifters for
Free-Space Laser Communication Transceiver Systems

A04-036 Radar Target Signature Modulator

A04-037 New Concepts and Tools for Unit Design and Evaluation

A04-038 Soldier Universal Robot Controller

A04-039 RF Unattended Ground Sensors (UGS) for Retargeting

A04-040 Innovative Gas Path Sealing Concepts for Improved Turbine Engine
Performance

A04-041 Multipurpose Reactive Materials

A04-042 Blast Damage Analysis

A04-043 Manpower and Personnel Estimation Methods for Post-Deployment
Software Maintenance

A04-044 Flexible Transparent Conducting Films

A04-045 Advanced Ultra Broad Band Direct Conversion Digital Receiver

A04-046 Development of Long Ceramic Tubes for Gun Barrel Applications

A04-047 Graphical/Visual Multiscale Model Builder & Data Structure
A04-048 InGaN Channel HEMTs for High-Frequency, High-Power Electronics
A04-049 Highly Efficient, Power-Scalable Long-Wavelength Diode Laser
Pumps for Eye-Safe Solid-State Laser Development
A04-050 Composite Proton Exchange Membranes for Multifunctional Power
Generating Structures
A04-051 Development of an Unattended Ground Sensors (UGS) Dispenser for
a Small Unmanned Ground Vehicle (SUGV)
A04-052 Advanced Metal-Air Batteries
A04-053 Controllable Direct Electrical Conversion of Isotopic Radiation
A04-054 Miniature Actuators for Small Arms Munition Control
A04-055 Command Decision Modeling in Distributed Combat Simulation
A04-056 Bio-Based Nano-Electronic, Electro-Optical, or Semiconducting
Device Materials
A04-057 Signal Enhancement Technology for Advanced Microplasma-Based
Force Protection Sensors
A04-058 Rifling of the Inner Surface of Ceramic Tubes
A04-059 Macro-Fiber-Composite Power Module
A04-060 Vehicle-Based Detection and Neutralization Methods-Devices for
Roadside Bombs and Hard Wired Munitions

Army Research Office (ARO)

A04-061 Studies of Stochastic Pursuit-Evasion Differential Games with
Multi-Pursuers and Multi-Evaders
A04-062 Solid Sorbent Trap for the Safe Handling of Chemical and
Biological Contaminated Materials
A04-063 Identification and Characterization of Molecular Inhibitors of
Cognitive Performance
A04-064 Anomaly and Fault Detection for Mobile Ad Hoc Communication
System
A04-065 Innovative Hosts for Bacteriorhodopsin-Based Optical Memory
A04-066 Integration of Airborne Doppler Lidar Data into Real Time
Analysis and Fusion of Battlefield Weather Conditions
A04-067 Bistable Lattice Composites for Armor
A04-068 ZnO Based Light Emitters for UV/Blue Applications
A04-069 Compact Alkaline Fuel Cell System

A04-070 Innovative Standoff Sensor Technology for Military Robotics
Platforms

A04-071 Repair, Regeneration, and Differentiation in Humans

A04-072 An Atmospheric Surface Layer Profiler

A04-073 Visual Stoichiometry Breaking in Linear Response Chemical Test
Strips

A04-074 Intelligent Force Management

Army Test & Evaluation Center (ATEC)

A04-075 Unmanned Aerial Vehicle (UAV) Close-Formation Control System
(CFCS)

A04-076 Chemical Cloud Tracking Through Hyperspectral Imaging

Aviation RD&E Center (AVRDEC)

A04-077 Prognostic Wear Prediction Tool for BlackHawk Hanger Bearings

A04-078 Obstacle Display for Hover in Degraded Visual Environments

A04-079 Electromechanical Actuator Controller Technology

A04-080 Combat Rotorcraft EMI Suppression Technology (CREST)

A04-081 Automated Air Traffic Control (ATC)

A04-082 Advanced Flow Control Actuators for Fuselage Drag Reduction

A04-083 Advanced Stress Measurement Technologies for Small Turbine
Engines

A04-084 Oil Free Couplings For High Speed Turboshaft Engines

A04-085 An Aerodynamic Tool for Rotorcraft Brownout Analysis

A04-086 Single Crystal Piezoelectric Actuators for Rotorcraft

A04-087 Improved Models for Coated CMC Components with Severe Thermal
Gradients

A04-088 Integration of Active Flow Control Concepts into Rotorcraft
Analyses

A04-089 Ducted Fan Model for Real-Time Rotorcraft Flight Simulation

A04-090 Flight Control System Using Secondary Systems (FUSS)

A04-091 Crashworthy Ballistic Tolerant Fuel Tank Weight Reduction

A04-092 Reconfigurable Multimodal Control Station (RMMCS) for UAV
Control

A04-093 Modeling and Analysis of Rotor Blade Erosion
Phenomena/Mechanisms

**Communications Electronics Research, Development & Engineering Center
(CERDEC)**

- A04-094 C4ISR Architecture and Tactical Systems Planning Tool
- A04-095 Remotely Controlled Neutralization Techniques for Mine Clearance
- A04-096 Advanced Algorithms for Unmanned Systems Resource Optimization
- A04-097 Self Contained Displacement or Velocity Sensor
- A04-098 Power The Force: Future Force Power Systems- Critical Enabler
for Army Transformation
- A04-099 Integrated Biometrics for Handheld and Mobile Devices
- A04-100 Information Distribution for Handheld and Mobile Devices
- A04-101 Arabic to English Machine Translation System
- A04-102 Full Color, Flexible, Day/Nighttime Displays for Mobile Battle
Command Environments
- A04-103 Handheld Positioning/Navigation System for Urban and Indoor
Environments
- A04-104 Co-Channel Interference Mitigation Test Apparatus
- A04-105 An Ontologically-Based Data Fusion Model
- A04-106 Integrated Wideband Signal Intelligence (SIGINT) Sensor
- A04-107 JAVA Raw Socket and Network and Transportation Protocol Layer
Application Programming Interface (API)
- A04-108 Advanced Visualization Support of Higher-Level Fusion Processes
- A04-109 Small Arms Fire and Alternative Missile Launch Detection
- A04-110 Wideband Collection
- A04-111 Commercial Radio Based Identification
- A04-112 Ultra-Lightweight Moving Target Indicator (MTI) Radar for
Unattended Ground Sensors (UGS) and Organic Aerial Vehicles (OAV)
- A04-113 Wireless Local Area Network (LAN) Based Surveillance System
- A04-114 Small, Low Cost, Long Wave Infrared (8.5-12 Micron)
Semiconductor Laser for Military Platform and Perimeter
Protection, Free Space Communications and Chemical Sensing
- A04-115 Mobile Sensor Systems for Intelligence Collection Using Doppler
Shifting of Existing Communication Technology
- A04-116 Passive Low Light Level Solid State Silicon Imaging Camera
Development
- A04-117 Uncooled Midwave Focal Plane Array (FPA) and Camera for RPG
Detection

- A04-118 Acoustic Landmine Detection
- A04-119 High Performance Longwave Infrared (LWIR) HgCdTe on Silicon
- A04-120 Novel Hyperspectral Sensor Components
- A04-121 Passive Ranging with Motion Detection
- A04-122 Innovative 3-D Imaging for Uncooled and Low Light Level Sensors
- A04-123 High Performance Low-Profile Wave-Guided Head Mounted Display
- A04-124 False Alarm Mitigation and Highly Flexible Non-Parametric
Decision for Airborne Minefield Detection
- A04-125 Scene Based Non-Uniformity Correction For Infrared Focal Plane
Arrays (IRFPAs)
- A04-126 Automatic/Assisted Recognition of Human Intention and Human
Group Activity Intention in IR Images
- A04-127 Modeling and Simulation of Spectral and Spatial Efficiency,
Communications Bandwidth and Range Optimization and Security
Performance in a Directional Networked Communications Environment
- A04-128 High Efficiency Monolithic Microwave Integrated Circuit (MMIC)
Power Amplifiers For SATCOM
- A04-129 Networked Micro-Radios for Micro-UAVs
- A04-130 Laser Agile Multibeam Payload
- A04-131 RF (Radio Frequency) Communications for Unattended Ground Sensor
and Munition Systems
- A04-132 Models for Accurate & Scalable Analysis of Future Communication
Systems
- A04-133 Superconductor Technology for SATCOM Applications
- A04-134 Multi-Band Satellite Terminal Feed Development
- A04-135 Subterranean Communications for First Responders and the
Military
- A04-136 Computer Network Intrusion Tolerance and Survivability for Army
Mobile Tactical Networks
- A04-137 Network Scalability and Performance Analysis
- A04-138 Modeling of Composite Materials for a Survivable Ballistic
Antenna Radome
- A04-139 Biobatteries

Edgewood Chemical Biological Center (ECBC)

- A04-140 Carbon Nanotube Obscurants for Survivability

A04-141 Ultra-Compact Carbon Dioxide Laser For Chemical Sensor

Engineer Research & Development Center (ERDC)

A04-142 Development of a Fluorescence Lifetime Imaging System for Remote Sensing

A04-143 Self Calibrating, Self Locating Seismic-Acoustic Sensor System

A04-144 Self-Powered Sensors for Structural Assessment of Bridges

A04-145 Course-of-Action Forecasting

A04-146 Detector Array for Aerosol Particles

A04-147 Biological Warfare Agent (BWA) Countermeasures in Heating, Ventilation, and Air Conditioning (HVAC) Systems of Army Installation Buildings

A04-148 Remote Acoustical Reconstruction of Cave and Pipe Geometries

A04-149 Electrokinetic Soil Stabilization for Rapid Construction

A04-150 Electrokinetic Generation of Biocides for Advanced Air and Water Filtration to Mitigate Biological Threats

A04-151 GeoText

A04-152 Soil Imaging System

A04-153 Scalable Wireless Geo-Telemetry Capability for Miniature Smart Sensors

Missile RD&E Center (MRDEC)

A04-154 Guidance Technique for a Low-Cost Kinetic Energy Interceptor

A04-155 Low Cost Adaptive/Programmable Waveform Generator

A04-156 On-Demand Gas Generator with Real-Time, Open-Loop Control System for Gel Propulsion

A04-157 Protective Coating for ZnS Windows & Domes

A04-158 Unmanned Air Vehicles Diagnostics/Prognostics

A04-159 Innovative and Cost Effective Obstacle Avoidance/Navigation for Small Tactical Unmanned Aerial Vehicles (UAVs)

A04-160 Innovative Software Anti-Tamper Techniques

A04-161 Stabilization Technology/Techniques for use with Commercial Uncooled Infrared Technology

A04-162 Advanced Rendering Algorithms for Real-Time Physics-Based Sensor Scene Generation

A04-163 Energy Harvesting for Missile Health Monitoring

- A04-164 Corrosion Sensors for Army Missile Systems and Aircraft Applications
- A04-165 Integration of Multiple Models and MEMS Data into Computer Algorithms for Safe/Shelf Life Prediction of Rocket Motors
- A04-166 Infrared Seeker Algorithm Evaluation Testbed
- A04-167 Low-Cost, Large-Area Conformal Detector Arrays
- A04-168 Non-Intrusive Measurement Techniques for Scramjet Ground Test Environments
- A04-169 Innovative Hardware Anti-Tamper Techniques
- A04-170 Consolidation of Nanograin Ceramics
- A04-171 High Strength Nanomaterials Fiber for Lightweight Composite Missile Cases
- A04-172 Affordable Efficiency Improvements for Small Turbine Based Flight Engines
- A04-173 Alternate Scramjet Fuel Modeling and Evaluation
- A04-174 An Integrated Thrust Control Solution
- A04-175 Development of a Highly Integrated Multifunctional Optical Sensor for Monitoring Weapons Health and Battlefield Environments
- A04-176 Strategically Tuned Absolutely Resilient Structures

Medical Research and Materiel Command (MRMC)

- A04-177 Field Deployable Diagnostic Test for Active Cutaneous Leishmania and a Test for Latent Infection
- A04-178 Development of an Intracavitary Hemostatic Agent for Use in Noncompressible Hemorrhage
- A04-179 Human Biomonitoring Device for Military-Relevant Chemical Exposures
- A04-180 Developing a Catalytic Bioscavenger for Organophosphorus Nerve Agents
- A04-181 Nonviral Gene Therapy
- A04-182 Medical Simulation Training for First Response to Chemical, Biological, Radiological, Nuclear Events
- A04-183 Broad-spectrum Prophylaxis for Infectious Diarrhea in Deployed Military Forces
- A04-184 Hemorrhage Control for Non-Compressible Extremity Injuries
- A04-185 Automated Interactive Coping Skill and Resiliency Tool

- A04-186 Development of a Viral Based Gene Delivery System for Chemical Agent Bioscavengers and Biological Agent Vaccines
- A04-187 Developing Nanotechnologies for Detection and/or Targeted Treatment
- A04-188 Fatigue and Performance Modeling of Sleep-Deprived Soldiers
- A04-189 High Throughput Genomics Screening for Malaria Antigen Discovery
- A04-190 Antimicrobial Bone Graft Substitute
- A04-191 Soldier Mounted Eye Monitor
- A04-192 Novel Protein Nanodelivery Systems for Biological Agent Countermeasures
- A04-193 Simulation-Based Open Surgery Training System (SOSTS)
- A04-194 Development of High Throughput Bioassays to Identify Correlates of Protective Immunity Against Malaria
- A04-195 Ballistic Protection for Army Aviation Helmets
- A04-196 A Homologous Non-Human Primate Model System for Producing and Testing Recombinant Human Compatible Serum Butyrylcholinesterase
- A04-197 Smart Devices/Instruments For a Sophisticated OR Environment
- A04-198 High-Throughput Proteomics Strategy for Detection and Identification of Biomarkers of Malaria Exposure
- A04-199 An Active Noise Reduction Communication Earplug for Helicopter Crew
- A04-200 Volume Conduction Invasive Medical Data Communication System
- A04-201 Novel Routes of Drug Administration to Enhance Compliance in Soldiers

Natick Soldier Center (NSC)

- A04-202 Metabolic Engineering for Performance Enhancement
- A04-203 Miniature, Low Cost Real-Time Weather Sensor for Airdrop
- A04-204 High Performance Rechargeable Conformal Battery
- A04-205 Smart Terrain for Autonomous Agent Applications
- A04-206 Detection of Protease Activity for the Identification of Biological Toxins and Exposure to Chemical Warfare Agents
- A04-207 Solar Cogeneration of Electricity and Heat for Field Kitchens
- A04-208 Variable Glide Aerial Delivery Parachute Systems
- A04-209 Design, Synthesis and Preparation of New Azobenzene Materials for Use in Broadband Laser Eye and Sensor Protection

- A04-210 Solar Refrigeration
- A04-211 Onsite Field-Feeding Waste to Energy Converter
- A04-212 Shelter Fabric and Soldier Uniform Textile-Mounted Electronic Displays for Military Command Functions
- A04-213 Low Drag, Low Cost Suspension Line Technology for Parachutes
- A04-214 High Efficiency Shelter Lighting Utilizing Solid State Illumination Technology
- A04-215 Novel Conductive Fibers for Multi-Path Power/Data Transfer Embedded in Textile Substrates of Warrior Clothing & Equipment
- A04-216 Computer Input Devices and Embedded Sensors in Future Warrior Handwear (Gloves)
- A04-217 Anti-Personnel Blast Mine Protection

Space and Missile Defense Command (SMDC)

- A04-218 Enhanced Lethality Munitions for Army Applications
- A04-219 Advanced Guidance, Navigation and Control (GNC) Algorithm Development to Enhance the Lethality of Interceptors Against Maneuvering Targets
- A04-220 Passive, Active Stokes Polarization Imaging System
- A04-221 High Power Microwaves

Simulation, Training & Technology Center (STTC)

- A04-222 Low Cost Wide Field of View Head Mounted Display for Aviation Training
- A04-223 Distributed and Collaborative Information Environment for Embedded After Action Review Technologies
- A04-224 Visual Aid for Multi Resolution Federation Planning and Development
- A04-225 Innovative Concepts for Low-Cost Multi-Spectral Targets for Gunnery Training
- A04-226 Intelligent Agents for Real-Time Story Adaptation for Training Assessment
- A04-227 Innovative Wireless Network Modeling And Simulation Technology In Support of Training, Testing And Range Instrumentation Requirements

Tank Automotive RD&E Center (TARDEC)

- A04-228 Continuous Dynamic Processing of Ceramic Tiles for Ground Vehicle Protection
- A04-229 Automated Propagation of Design Intent from Legacy Drawings to 3D Models
- A04-230 Optically Clear Armor Protection
- A04-231 Composite Structures for Ballistic Protection
- A04-232 Polarimetric Sensors for Robotic Vehicle Perception
- A04-233 MEMS Based Micro Technology Engine Management/Health Monitoring System
- A04-234 Standoff Improvised Explosive Device (IED) Detection System
- A04-235 MEMS Testing Simulator
- A04-236 Sensor Technology for Materials Characterization aboard the Mobile Parts Hospital
- A04-237 Development of Blast Event Simulation
- A04-238 Visualization Tool for Animating Combined Multibody Dynamics and Computational Fluid Dynamics Simulations
- A04-239 Multi-Resolution Modeling of Ground Platform Dynamic Performance and Mobility
- A04-240 High-Power, High-Voltage, Bidirectional DC-DC Converter
- A04-241 High Power Density, High Torque Density, Efficient Electric Motors and Generators
- A04-242 Filtration and Enhanced Sensor Technology (FEST)
- A04-243 Design of New Technology Final Drives for 21st Century Military Vehicles
- A04-244 Advanced Suspension Characterization Test Fixture
- A04-245 Advanced Military Fuel Cell Applications
- A04-246 Development of a Characterization Test System for Powertrains of Military Vehicles
- A04-247 Complex Electronics Packaging Thermal/Signature Management Design Tool
- A04-248 Cooling Objectives and Operative Leverage (COOL) Techniques
- A04-249 Advanced Military Hybrid Technology
- A04-250 Development of Endurable Thermal Barrier Coatings for Diesel Engine Specific Heat Reduction
- A04-251 Modular Generic Voltage Converters

- A04-252 Hands-Free Tele-Operation Via Physiological Signal Recognition
- A04-253 Fuel Lubricity Evaluator Sensitive to Additives
- A04-254 Preservative/Break-in Lubricating Oil
- A04-255 Assured Operational Mobility Across Gaps for the Future Combat
Systems/Future Force) FCS/FF
- A04-256 Multi-Power Source for MEMS Packaging
- A04-257 Advanced Military Trailer Technology
- A04-258 Enhanced Access Control within a Pervasive Computing (PvC)
Environment
- A04-259 Tactical Biorefineries

DARPA

- SB043-036 Novel Low-cost Methods for Fabricating Compact, Vertically Integrated MEMS
- SB043-037 Orthogonal Communications
- SB043-038 Ad Hoc Networking Over In-Building Power Lines
- SB043-039 Bio-Inspired Sensory Systems
- SB043-040 Deductive Spreadsheets
- SB043-041 Tactical Group Decision Analysis Support System
- SB043-042 Adaptive Command and Collaboration
- SB043-043 RF Time of Flight Ranging Techniques for Self-Localization of Microsensors
- SB043-044 Narrow-Linewidth 1550 Nanometer Laser Oscillator
- SB043-045 Nano-Imprint Mask Technology
- SB043-046 Advanced, Regenerable Chemical and Biological Filters
- SB043-047 Integrated Wafer Phased-Array Antenna
- SB043-048 UAV Survivability Enhancement via Agile Maneuvering in Dynamic Environments
- SB043-049 Agile Maneuvering Using Dynamic Control Surface Morphing

NAVY

- N04-183 Nanotechnology Fabric Innovation
- N04-184 Development of Optimal Light Weight Personnel Armor Systems
- N04-185 Liner Material for CB Protective Garment
- N04-186 Expeditionary Meteorological Capability for Fire Support
- N04-187 Target Location Technology for Ground Based Observers
- N04-188 High Mobility Removable Camouflage System
- N04-189 Improved Sealed Enclosure
- N04-190 Low Cost, Low Weight, Self-Sealing Fuel Tank Technology
Development
- N04-191 Suspension and Track Noise and Vibration Reduction for Marine
Corps Advanced Amphibious Assault Vehicle (EFV)
- N04-192 Development of enhanced active damping system for the Marine
Corps Expeditionary Fighting Vehicle (EFV)
- N04-193 Integrated Trailer, Generator, Environmental Control Unit (ECU)
- N04-194 Ultra Lightweight Battery Charger/Generator
- N04-195 Human Fatigue Modeling
- N04-196 Public Key Certificate Acceptance Technology
- N04-197 "Smart Dust" and Nanotechnology for Joint Weapons Systems
Diagnostics/Prognostics
- N04-198 Persistent Illuminators as a Replacement for Tritium in Weapons
Sights
- N04-199 Automated Weapons Assembly
- N04-200 Lightweight Fire Insulation
- N04-201 Small, Cost Effective Mine Location Marker
- N04-202 JTRS Compliant Antenna for 21" Unmanned Undersea Vehicles
- N04-203 UAV-based mine detection using a short pulse, high repetition
rate, multicolor laser transmitter
- N04-204 Pressure Tolerant Power Source for Off-Board Sensor
- N04-205 Underwater Acoustic Positioning System
- N04-206 Multi-Vehicle Mission Planner for Unmanned Vehicles
- N04-207 Multi aspect sonar classification for High Resolution Broadband
Sonar (HRBS)
- N04-208 Acoustic Surveillance Multi-Array Search Aid CANCELLED
- N04-209 Solid-state LIDAR Chip

N04-210 Avoidance of Twinline Towed Array Entanglement

N04-211 Heat and Humidity Cumulative Exposure Sensor

N04-212 Technology for Advanced Ship Designs

N04-213 Advanced Structural Development for Cargo Stowage Systems

N04-214 Comprehensive Spectrum Management for Wireless Networks

N04-215 Sensor Synchronization Technologies

N04-216 Power generation for weight and space limited USV systems

N04-217 Multi-function Connectors for Shipboard Equipment

N04-218 Algorithms for Rapid and Accurate Depth Localization of Targets
for Mine Avoidance

N04-219 Object Avoidance for Unmanned Surface Vehicles (USVs)

N04-220 Embedded Pressure Sensors for Automation and Control of Fluid
Valves

N04-221 Acoustic, Thermal and Fire Insulation System

N04-222 Active Noise Reduction Technology

N04-223 Total Ship Computing Environment Infrastructure (TSCE-I)
Hardware and Software Technology

N04-224 Elimination of Wood Dunnage in Trucks, Railcars, ISO Containers
and Combat Logistics Force (CLF) Ship Cargo Holds

N04-225 Stable Platform Module for Ships

N04-226 Large Format Monolithic CCD Camera

N04-227 Integration and Optimization of Hydrogen Production with Ocean
Thermal Energy Conversion Technology in Offshore Floating
Platforms

N04-228 Development of a Sensor System for Reliable, Automated Detection
of Surfaced Swimmers

N04-229 Secure Communications in a Noisy Environment

N04-230 Data Fusion for Geophysical Aided Navigation Technologies

N04-231 Display and Visualization of Movement Predictions for Ground
Vehicles

N04-232 Altitude, Latitude, and Longitude Reference Database of Man-Made
Obstacles

N04-233 Object/Target Discrimination, Recognition, and Identification

N04-234 Hypersonic Infrared Dome

N04-235 Portable Handheld Imaging Radar System Technology

- N04-236 Enhanced Data Link Performance in Multipath and Interference Environments
- N04-237 Mobile Shallow Water Antisubmarine Warfare (ASW) Target System
- N04-238 Cosite Interference Reduction for Electronic Attack Aircraft
- N04-239 Advanced Ram Air Driven Power and Cooling Unit
- N04-240 Advanced Nonskid Coating System for Mobile Airfield Landing Mats
- N04-241 Detecting Target Maneuvers with the Radar Range Rate Measurement
- N04-242 Rugged, Low-Cost, Nondielectric Missile Radome
- N04-243 Multi-Level Secure High-Speed Shared Memory Interconnect
- N04-244 Field Programmable Gate Array (FPGA) Processor Firmware Development Modularization Methodology
- N04-245 Light Detection and Ranging (LIDAR) Surface Feature Extraction Tool
- N04-246 Management of Imagery Data in Simulation Training Systems Via Content Based Retrieval and Indexing
- N04-247 Littoral Environment Parameter Estimation from Bistatic and Multistatic Fleet Air Antisubmarine Warfare (ASW) Acoustic Reverberation Data
- N04-248 Low Cost Three-Dimensional Reinforced Ceramic Matrix Composites (CMCs)
- N04-249 Innovative Quality Control Assessment Methods for Ceramic Matrix Composite (CMC) Components
- N04-250 Environmental Resistance for Ceramic Matrix Composites (CMCs)
- N04-251 High-Temperature Sizing Development
- N04-252 High-Temperature Adhesive Development
- N04-253 Threat Spectrum Direction Finding Unit
- N04-254 Low-Cost Fiber-Optic Connector Cleaner
- N04-255 Maintainer Head and Hearing Protection
- N04-256 Wireless Sensors with Advanced Detection and Prognostic Capabilities for Corrosion Health Management
- N04-257 Enhanced Rotorcraft Aerodynamic Modules to Support Flight Testing
- N04-258 Advanced Fault and Failure Anomaly Detection Technologies to Support Enhanced Prognostics and Health Monitoring (PHM) Capabilities
- N04-259 Ni-Cad Battery State-of-Health Indication Improvements

- N04-260 Embedded Wiring Diagnostic Technology for Aircraft
- N04-261 Erosion Resistant Coatings for Shaft-Driven Compressor (SDC)
Impellers
- N04-262 Automated Nondestructive Evaluation (NDE) System for Finding
Foreign Materials and Contaminants in Manually Fabricated
Composite Components
- N04-263 Advanced Multi-Band Electronic Surveillance Measure (ESM)
Antenna
- N04-264 Automated Software Architecture Analysis and Visualization
Advanced of Large, Mixed-Language Systems
- N04-265 Miniature GPS Antenna System

SPECIAL OPERATIONS COMMAND (SOCOM)

SOCOM04-006 SOF Tactical Repeater

SOCOM04-007 Vertical Wind Profile Data Collection Using Laser Technology
on Unmanned Delivery Platforms

SOCOM04-008 Alternative Power Sources

SOCOM04-009 Image Intensified Lightweight Lens Development

OSD**Information Systems Technology Area**

OSD04-SP1 Attack Modeling Technology and Methodology
 OSD04-SP2 Next Generation Software Reverse Engineering Tools
 OSD04-SP3 Automated Tools for Software Protection Technology Insertion
 OSD04-SP4 Polymorphic Software
 OSD04-SP5 Behavior Based Malicious Logic Monitoring and Detection
 OSD04-SP6 Code Pedigree, Code Integrity, Tamperproofing, Software
 Protection, Software Security
 OSD04-SP7 Software Pedigree Analyzer
 OSD04-TC1 Technology for Trusted Circuits

Materials/Processes Technology Area

OSD04-C01 In-Situ Smart Corrosion Sensors for Water Piping Systems
 OSD04-C02 Investigation of Electrophoresis as a Novel Coating Mechanism
 for Sealing Concrete
 OSD04-C03 Corrosion Prevention of Steel Reinforcements in Concrete in
 Bridge Decks and Piers, and Structures Through Electrokinetic
 Control of Chloride Ion Migration
 OSD04-C04 Smart Self-Healing Nanotechnology Coatings
 OSD04-C05 Concrete Admixtures that Defend Against Salt Scaling and
 Freeze-Thaw
 OSD04-C06 Development of a Crack Resistant Durable Concrete Repair
 Material for Navy Concrete Structures
 OSD04-C07 Embrittlement Fuse to Detect the Presence of Hydrogen Assisted
 Cracking (HAC) Effects in High Strength Materials
 OSD04-C08 Sensors for the Automation of Biofouling Control
 OSD04-C09 Model Corrosion Protection System Breakdown Utilizing Existing
 Data
 OSD04-C10 Development of Corrosion Test to Predict or Rank Corrosion
 Performance of Current and Novel Corrosion Inhibiting Sealants,
 Both Conductive and Non-Conductive, in Aggressive Environments
 OSD04-C11 Development of a Portable Visible Light System for Curing
 Visible Light Cured Coatings for Corrosion Protection
 OSD04-C12 Methodology for the Prediction of Corrosion Costs

OSD04-C13 Corrosion Inhibitor and Chemical Warfare (CW) Agent Cleaner
for Military Hardware

OSD04-C14 Low Cost Corrosion/Corrosivity Sensor Systems For Ground
Vehicles

OSD04-C15 Galvanic Corrosion Due to Composite/Metal Direct Contact

OSD04-C16 Aluminum Cleaning Methods

OSD04-C17 Advanced Materials for Space Environment Protection of
Polybenzoxazole Polymers

OSD04-L01 Polycrystalline Laser-Host Material

Energy & Power Technology Area

OSD04-EP1 Advance Cooling Designs for High Temperature Transformers and
Inductors for Power Electronics

OSD04-EP2 New High Energy Density Li/Li-Ion Rechargeable/Primary and
Alternative Design Munition Batteries

OSD04-EP3 Nanostructure-Enhanced Bulk Thermoelectric Materials

OSD04-EP4 Cryogenic Power Electronics

OSD04-EP5 Lightweight Power Transformer for Shipboard Electrical Power
Distribution Systems

OSD04-EP6 Superconducting Developments for Compact Power and Energy
Systems

OSD04-EP7 High Performance Dielectric Materials for Pulse Power
Capacitor Devices

OSD04-EP8 Advanced Thermal Management Concepts Using Designer Thermo-
Fluids

OSD04-EP9 Innovative Advanced Fuel Cell Manufacturing

Defense Health Program Biomedical Technology Area

OSD04-H05 Large Area Millimeter Wave Dosimetry

OSD04-H06 Computer-Based Dynamic Patient Scheduling and Optimization of
Medical Resource Allocation

OSD04-H07 Field Optimization of Real-Time PCR for the Detection of
Leishmania Parasites

OSD04-H08 Development of a Field-usable Diagnostic Device for the
Detection of Leishmania Parasites in Sand Flies

- OSD04-H09 Rapid Determination of Complement Activation in the
Battlefield
- OSD04-H10 Sensor-Based Monitoring and Intervention for Gravity-Induced
Loss of Consciousness (GLOC)
- OSD04-H11 Simultaneous EEG Acquisition and Portable Near Infrared
Spectroscopy for Recognition of Traumatic Brain Injury Severity
and Outcome Assessments in Far-Forward Military Medical Care
- OSD04-H12 Digital Archive and Access to Lifetime Military Medical
Records
- OSD04-H13 Tool for Dynamically Integrating Military and Civilian
Telemedicine and Medical Informatics Systems for Homeland Security
- OSD04-H14 Develop Portable Near Infrared Technology for Detection of
Pulmonary Function Following Blast Injury
- OSD04-H15 Armed Services Blood Program (ASBP), Blood Reserve
Availability Surveillance System (BRASS)
- OSD04-H16 Armed Blood Services Program, Bloodborne Pathogen and Donor
Deferral Early Warning System
- OSD04-H17 Development of a Hemostatic Wound Dressing Incorporating
Lyophilized Platelets
- OSD04-H18 Armed Blood Services Program (ASBP), Donor Relationship
Management System (DRMS)
- OSD04-H19 Next-Generation Antibiotics

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